TOPICS OF THE MONTH

More steel wanted for chemical plant

THERE is no sign at present of any alleviation of the shortage of steel supplies which is hampering the chemical plant industry. This is despite a marked increase in the production of non-alloy and alloy steel during the past year or so. In its report for 1955, the British Chemical Plant Manufacturers' Association comments that the principal difficulty experienced by its members was in obtaining supplies of steel sections, plate and stainless steel. To a limited extent the shortage was made good by importing supplies at high prices. It is to be hoped that there will be a further increase in home production as the Association's investigations show that the chemical plant industry's steel requirements may be expected to increase.

Standardisation is another subject which engages the attention of the B.C.P.M.A., and the joint committee formed by the Association along with the Association of British Chemical Manufacturers to study this problem is reported to have made good progress. Its proposal for the preparation of standards for vacuum testing of chemical plant was accepted by the British Standards Institution and two B.C.P.M.A. representatives were appointed to the committee formed by the Institution for the purpose. Proposals for the revision and extension of the standard flange tables and for standard sizes of sight and light glasses were submitted to B.S.I. which also accepted the committee's request that the title of B.S. 1758—' Fireclay Refractories (Bricks and Shapes) for use in the Petroleum Industry '—be extended to include the chemical industry.

The committee continued its examination of the problem of the lengths over flanges of chemical valves, coming to the conclusion that the adoption of one or two standard overall lengths for all types of flanged valves of a given bore was impracticable. It did however take the opportunity when approached by B.S.I. in connection with the proposed standardisation of general purposes iron and steel valves, of stressing the importance of including standard lengths in any new valve standards issued.

Appointments were made to five more B.S.I. committees during the year, bringing the number on which the Association is represented to thirty-nine.

New £2-million gas pipeline for Pakistan

ANOTHER natural gas pipeline is being planned for West Pakistan, according to news received from Karachi which reveals that Pakistan Constructors, the joint venture of D. & C. and William Press Ltd., London, and Morrison-Knudsen International Corporation Inc., San Francisco, have signed a contract with the Pakistan Industrial Development Corporation for the installation of a 212-mile natural gas pipeline in West Pakistan running from the Sui gas field in Baluchistan to Multan in the Punjab. The work is due to start in December of this year.

The contract, which has been let on the basis of a bid item for each individual operation, is valued at approximately £2 million sterling. The outer diameter and wall thickness of the pipe are 16 in. and $\frac{5}{16}$ in. respectively, the same dimensions as the pipe used on the 350-mile Sui-Karachi line, completed ahead of schedule by the same contractors in April of last year. Fifty per cent. of the pipe for the Multan contract is being supplied by Stewarts and Lloyds and 50% by Dalmine of Italy.

The pipeline route, which was surveyed and determined by D. & C. and William Press Ltd., runs in an easterly direction initially until it crosses the river Indus at Kashmor. It then proceeds along the east bank of the river Indus, bearing east and then northeast, crosses the river Sutlej and thence into Multan. Apart from the two major river crossings, there are a considerable number of canal and road crossings to negotiate. The managing agents on behalf of the Pakistan Industrial Development Corporation are the Sui Gas Transmission Co., who filled the same role on the Sui-Karachi pipeline contract.

It is possible that a decision may be made in the near future to extend the pipeline from Multan to Lahore, a distance of about 200 miles.

Industry needs technical leaders

THE ' archaic ' state of affairs in which Britain's largest industries—the nationalised industries—although highly technical in character, are controlled by men without technological knowledge and by retired soldiers, was deplored by Mr. J. A. Oriel, C.B.E., M.C., in his presidential address to the Institution of Chemical Engineers. When there are such great technical improvements at hand, he pointed out, it is regrettable we should not have, at the head of affairs, men with technical imagination capable of inspiring those who are attempting to work under them.

On the subject of the universities, Mr. Oriel said that one way in which they are failing at present—and this criticism might well be levelled more at Oxford and Cambridge than other universities—is that they hang on to their graduates for far too long. He expressed a belief that the normal period of undergraduateship of three or four years is in most cases long enough for a man before moving out into industry or teaching. A longer period than this was enervating and was often the cause of that reluctance which one notices on the part of men to leave the safety of the university for the unknown world outside. The universities should retain only a very small number of

those who have obtained their first degree and assure themselves before retaining them that they are really men who can benefit by a period engaged in research. Even so, Mr. Oriel suggested, research should be carried out at a different university from that in which they took their first degree.

Others who clearly would make first grade technologists, who would become our leaders in the development of technological projects, who appear most capable of translating scientific discovery into practical propositions, should move on to a new college where they would receive postgraduate technological education. This college should also be open to men who have already spent from two to five years in industry. There, men straight from the university and others from a variety of industries could rub shoulders with one another. There, we could expect to find such an exchange of ideas and techniques as would really make this country a leader in quality of technologists, knowing full well that we cannot hope to lead in quantity.

Education and plastics

ANOTHER recent speaker on technological education was Prof. Sir Eric Rideal, chairman of the Advisory Council of the D.S.I.R. and founder of the department of Colloid Science at Cambridge, who, at a special meeting of the Plastics Institute's London Section, was concerned with the problem as it affects the plastics industry. He warned that the industry should not rely on methods and processes bought from the U.S. and Germany, as it had done in the past, and as it might have to do in the future. In his opinion neither the present work at Cambridge, the Borough Polytechnic, nor anywhere else in Britain, was adequate for the needs of the plastics industry. There were glaring deficiencies, resulting in the fact that Britain was not, as a nation, producing scientifically trained men suitable for the industry. Nor was there any centre for fundamental research of a co-ordinated kind.

Prof. Rideal based his argument on the fact that much work, for example the kinetics of polymerisation, involved intellectual problems, immense in their scope, and this was why the universities had restricted their work to problems of this kind. He regarded these intellectual subjects as forming the first stage of development, in contrast to the work at Yale and elsewhere on polymer solutions, molecular weight distribution, vapour pressure, melting point, etc., which he regarded as forming the second stage. In this group, whilst much was being done at Aachen, Zurich, M.I.T., Cal. Tech., Brooklyn and elsewhere, little or no work could be cited in Britain, outside commercial laboratories.

The third stage was envisaged as embracing such applied properties as creep, crazing, elastic and plastic properties, and this group, he said, was not provided for at university level at all. Sir Eric expressed the belief that an ideal polymer course must embrace the three stages of development which had been outlined.

I.C.I. is still growing

THE wider the field of a chemical company's activities, the wider too must be its enquiry into the basic chemistry and physics underlying the processes involved. It is only through possession of such knowledge that prompt action can be taken to match advances made by competitors or to modify existing products to meet new demands from customers.

A recent example is provided by the prompt reply which I.C.I. has been able to make to the introduction of new types of high-density polymer obtained by low-pressure polymerisation processes developed in Germany and the United States. Before any of these were in commercial production in Britain, I.C.I. was able to announce its ability to produce similar products by modification of the high-pressure process originally invented in its Alkali Division laboratories. This achievement is referred to in the company's annual report, which comments that more and more the main consideration with regard to research and development is not the amount of money which can justifiably be spent on it but the availability of suitable staff with scientific and technological education and training.

On the operational side, the report reveals a wealth of new developments of which only a few can be mentioned here. A good feature is the continued increase in home sales of alkali products, these increases being spread over a number of different uses. One use which has developed rapidly is for the manufacture of trisodium polyphosphate, a material used in synthetic detergents. Exports of alkali products also increased in volume. Arrangements were made during 1955 for shipping caustic soda liquor in bulk and the first ship-load of 9,000 tons, which was loaded in 24 hours, was sent to Jamaica in January 1956.

Undoubtedly one of the high lights of I.C.I.'s 1955 activities was the bringing into production of its new plant for the manufacture of 1,500 tons a year of granular titanium, this being the first commercial-scale plant in the world to manufacture titanium by the sodium route. The excellent results achieved have enabled the company, for the time being at least, to lead the world in the race for cheaper titanium. Meanwhile, research on the melting of titanium has continued and good progress was made in the melting of titanium scrap which will reduce the costs of wrought titanium production. A method has been devised of fabricating products such as refrigerator evaporators and other heat-transfer equipment by rolling together sheets of aluminium or copper, and forming the required channels in the rolled sheets integrally during the process.

Sales of salt during 1955 were about 10% higher than in the previous year. A new method of bulk delivery for dried vacuum salt has been developed in which the salt is carried in airtight containers mounted on road or rail vehicles and, on arrival at the customer's premises, compressed air is used to discharge the salt through a pipeline to a storage bin, which, if the customer so wishes, can be above ground level. This

system of delivery eliminates the need for bags, reduces the work of handling and keeps the salt perfectly clean during transit and unloading.

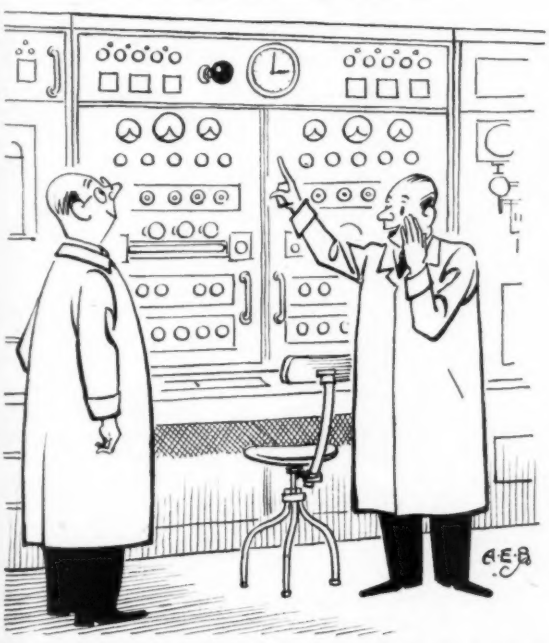
Fertiliser progress

A MOST successful year seems to have been enjoyed by I.C.I.'s Billingham Division, the value of whose sales was 16% higher than in 1954, and almost all plants operated at full output throughout the year. The demand for fertilisers continued to grow, and deliveries to the home market were the highest ever recorded. Production was seriously affected by an explosion in the ammonia plant in September 1955, and in order to meet the home demand it became necessary to refuse some export business. The company also reports that, to help to satisfy the continuously expanding market for nitrogenous fertilisers, additional capacity, both for ammonia and for fertiliser production is being erected. The new ammonia plant will be based on oil instead of coal.

At the Wilton works, good progress was made with the construction of the second oil-cracking plant and of the plants for making butadiene and converting it into rubber-like polymers, and by the year end there were nearly 500 men at work on the site for the Wilton nylon plant. The total design and construction effort at Wilton was greater than in any previous year, and the capital expenditure during the year on physical assets was over £11 million. This means that over £50 million in all have now been spent out of a total of £75 million so far sanctioned by the board for construction at Wilton Works.

At the close of the year the total of staff and labour employed by the company at Wilton had risen to 7,200 and in addition a force of 2,000 contractors' men was employed there.

Comical Engineering Situations



"AND THE RED LIGHT THERE SHOWS WHEN THE BOSS IS ON HIS WAY UP"

Bright prospects for oil

THE free world's expanding demand for petroleum, which increased by 11% in 1955, continues the post-war trend which has resulted in a doubling of world consumption of oil products in the last 10 years. The roots of this strong demand lie not only in the growth of industrial activity and improving standards of living; they also, in the Eastern Hemisphere, lie in the more limited capacity for increasing output of the other major sources of energy, especially coal.

Thus comments Mr. B. R. Jackson, chairman of the British Petroleum Co. Ltd., in his circulated statement. He goes on to point out that there is every indication that this combination of factors will maintain the post-war rate of expansion in world petroleum consumption until nuclear power becomes available to supplement world energy resources on a substantial scale. Thus in the next 10 years the world petroleum industry may well be again called upon to double its present output.

Certainly the present prosperity of oil production and refining ventures is reflected in a statistical review of the world oil industry for 1955 which has just been issued by British Petroleum. This shows, among other things, that world refining capacities at the end of 1955 had reached 829.5 million tons as against 792 million for 1954, this being made up of 553.8 million tons for the Western Hemisphere (542.0 million tons in 1954) and 275.7 million tons (250.6 in 1954) for the Eastern Hemisphere. The largest expansion occurred in the East of Suez area of the Eastern Hemisphere. During 1955 throughputs of Eastern Hemisphere refineries represented just under 90% of their rated annual capacity. Perhaps the best overall picture of the increase in world refining capacity is obtained by comparing the approximate total of 830 million tons at the end of 1955 with 645, 690, 725 and 793 million tons for 1951, 1952, 1953 and 1954 respectively.

British Petroleum's total refinery throughput in 1955 was 29½ million tons—5½ million tons more than in 1954. This increase was mainly due to 1955 being the first complete operating year of Aden refinery, and the first operating year of Kwinana refinery in Western Australia, commissioned in February, 1955; also to the company's share of processing at Abadan during its first complete year's operation under the Consortium agreement of October 1954.

In Great Britain, the total throughput of the Kent, Llandarcy and Grangemouth refineries decreased by some 2 million tons to 8½ million tons, this being due to the major increases in offtake from Aden, Kwinana and Abadan replacing the uneconomically routed pro-

ducts which had, during the last four years, to be drawn from the United Kingdom refineries to assist in the supply of Eastern markets.

At the Kent facilities, where lubricating oil production, at 84,000 tons, was more than double the 1954 figure, crude distillation capacity, now 4,600,000 tons, is to be increased to over 7 million tons. New plant for the manufacture of aviation spirit and improved diesel fuels is to be installed, and a further catalytic reformer to increase production of high-grade motor spirit. At the Grangemouth plant of British Hydrocarbon Chemicals Ltd. (as British Petroleum Chemicals Ltd. was renamed during the year) production of industrial alcohols reached a new high level. The first of the present major expansion projects—a plant for production of butadiene—is expected to be commissioned this year.

New fields for road tankers

BULK transport and handling of liquids is becoming an increasingly familiar topic all over the world and seems likely to find a place in more and more industries. Certainly in many cases the method has much to recommend it where economies in labour, space and containers, etc., can be achieved. Bulk transport by rail is already a well-tried method with some industries but it is only more recently that interest in road tankers and sea tankers has grown. In the chemical industry we have seen increased interest in the shipping of liquid caustic soda, sulphur, etc., in bulk by road and sea, while the brewery and dairy trades, in Britain at any rate, are among comparative newcomers to the field. In Canada, a new method of handling bulk liquids is being started experimentally between the Toronto plant of Lever Brothers Ltd., and the Newfoundland Margarine Co. Ltd., St. John's, Newfoundland.

Specially designed aluminium containers, set in steel cradles and each with a capacity of 12,000 lb. are being used. These containers are adapted for easy transfer between Canadian National Railway flat cars and the ferry at North Sydney, Nova Scotia, and Port Aux Basques or Argentia, Newfoundland.

The containers will be carried on flat cars held down by special fastenings. They will be handled between rail equipment and ships by mobile swivel cranes at the ports. At St. John's, they will be handled from rail line to the plant by a truck equipped with a special hydraulic lift. When empty, the containers, after steam cleaning, will be returned on the same flat cars for re-loading.

The liquids were previously shipped between Toronto and St. John's in specially lined 40-gal. drums. According to Lever Bros. the new method will facilitate the handling of the commodity and ensure that it reaches its destination in a shorter time and in fresher condition.

In the United States, a recent development in the chemical field is the introduction by Becco Chemical Division, Food Machinery and Chemical Corporation, of a new 2,000-gal. road tanker specially designed for the transportation of hydrogen peroxide and supplementing their large fleet of railroad tankers. Aluminium of a very high purity is used in the construction of the road tanker. Aluminium does not affect H_2O_2 purity and stability and permits greater loading tonnage than other compatible but heavier construction materials.

Being similar to water in many of its physical characteristics, hydrogen peroxide of course presents no handling problems, while freezing points of the various H_2O_2 concentrations are low enough to permit outside storage anywhere in the continental United States. Thus, to introduce the bulk road transport of a chemical such as this is quite a different proposition from using the same method with liquid sulphur, for instance (see CHEMICAL & PROCESS ENGINEERING, 1954, **35** (7), 217). However, wherever the advantages to both customer and supplier are sufficient to warrant it, no matter what the problems are with the particular liquid involved, the method is bound to creep in.

Hydrogen sulphide-corrosion menace

HOW the introduction of a new car in Detroit can affect a refinery in Texas—and develop a field of research distinct from both automotive and petroleum engineering—set the background for a talk delivered before the National Association of Corrosion Engineers in the United States recently. Mr. G. Sorell and Mr. W. B. Hoyt, of the M. W. Kellogg Co., pointed out that certain operating equipment of petroleum refineries has been experiencing severe corrosive attack under conditions at which little or no corrosion was anticipated, and the reason for this problem was attributed to the presence of hydrogen sulphide gas at high temperatures and pressures. These conditions are encountered in catalytic reforming. Corrosion by hydrogen sulphide is also a problem in catalytic desulphurisation-type units which have been finding application for 'sweetening' high sulphur content feed stocks derived from sour crude oils.

The authors stated that in view of the increasing numbers of installations of these two types of units, the attendant corrosion problem was of vital concern to the refining industry. The nature of this corrosion differs sharply in two important aspects from that long experienced in processing sour crudes in older types of units such as crude and vacuum distillation, thermal and catalytic cracking, thermal reforming and coking. Severe attack occurs at comparatively lower levels of sulphur content and, secondly, the chrome-moly steels previously considered effective in resisting 'sulphur attack' offer no improvement over plain carbon steel.

By way of an answer to this problem, the authors indicated that chrome-nickel stainless steels and aluminium coatings appear to be the only economic materials capable of withstanding this type of corrosive attack. In presenting their case, they developed corrosion summary charts for equipment design that predict the variation of corrosion rate with temperature, hydrogen sulphide partial pressure, and alloy content.

SIZE REDUCTION

Theoretical and practical advances in comminution, including crushing, milling, fine grinding, fluid energy mills, and size reduction machinery for special applications

By R. V. Riley, PH.D., B.SC., F.I.M.

A GREAT deal of information about current ore-dressing trends in various European countries is contained in an O.E.E.C. report[1] prepared by a team of experts on the mining and dressing of low-grade ores. This excellent report itself provides a useful contribution to our knowledge of the practice of size reduction as carried out in Europe but makes it clear that there is a dearth of theoretical information upon comminution processes.

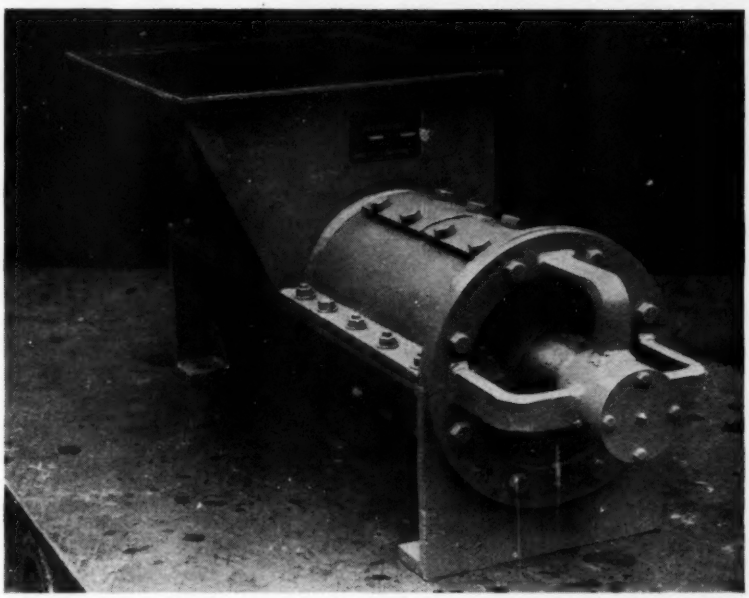
Huttig and Sales,[2] both well known for their writings in this field, claim that metals behave differently upon grinding, dependent upon whether they are brittle, tough or soft. Brittle metals, typified by tungsten, obey Rosin-Rammler's law, *i.e.*

$$R = 100 \exp. \left(\frac{x}{F}\right)^n$$

where R = residue percentage on a screen of mesh size x, and F and n are constants. (Under normal dry grinding in a mill without continuous screening, $n = 1$.)

Tough Ni—Cr—C alloys are almost impossible to crush and suffer merely a particle rounding action. Thus grinding proceeds *via* an abrasion mechanism. On the other hand, soft metals such as copper, zinc or aluminium and, to some extent, iron suffer particle flattening in the early stages but often become more brittle and obey Rosin-Rammler's law in the later stages of crushing, when the particle size is very small. The influence of grinding conditions upon the fineness of the grain was studied and it was found that wet grinding led to a reduction in the grinding time. Prolonged grinding of most metals, whilst reducing the grain size progressively, usually results in the oxidation of the particles and thus the process cannot be continued indefinitely.

Lehmann and Haese[3] attempted to formulate a standard of grindability based upon measurements made during experiments with cement clinker and barium oxide. Tanka[4] determined an empirical law for particle-size distribution after size reduction, which he claimed more accurately fitted the facts than the Rosin-Rammler exponential law. The general grinding laws of Kick and Rittinger were explained and compared in articles on jaw crushing and rotary grinders by Baouman.[5, 6] As examples of their application, he made reference to the grinding of clay-chalk mixtures in a three-compartment, compound rotary grinder. He also showed that the grindability of cement clinker depended largely upon the hardness, which in turn was related to the method of firing.



[*George Scott & Sons (London) Ltd.*

The Scott Rietz prebreaker is used for the preliminary breaking down of green bone, ribs, shanks, beef heads, etc. These machines operate at speeds of only 30 to 50 r.p.m. and have a high torque to enable them to carry out extremely tough jobs. By fitting an orifice plate on the delivery end, the machine can be made to give a graded product.

Roll mill studies

Although the three-roll mill has been widely used for the past 50 years for the production of dispersions, little fundamental data are published. Of particular value, therefore, are three studies recently recorded[7] which collectively provide a good understanding of roll mill design and use. In the initial study, only one nip at a time was considered, and the material used was an unpigmented oil. The variables investigated and correlated by dimensional analysis were roll speed, roll-speed ratio, clearance, viscosity, roll diameter, roll length, and power input. Correlation equations were developed according to fluid mechanics for two cases—a feed nip with a bank of material and an apron nip with a minimum of material. These correlations involve the Power number, Reynolds number, Froude number and roll speed number, so that the final equations took the form:

$$PN = K(RN)^a(FN)^b(RSN)^c$$

From this fundamental engineering study, a new mill was developed. Called the floating roll mill, one of the end rolls is fixed instead of the centre roll, so that only two screw jacks are needed to tighten and to adjust the mill. Thus the 80 possible ways in which the conventional four-point adjustment mill can be out of adjustment is reduced to eight. Increased production averaging 15% has been realised industrially because four-point mills are often run when out of perfect balance. Finally, using the floating roll mill, a correlating equation was developed for the complete three-roll mill and tested with extensive data:

$$PN = K(RN)^{-2/3}(FN)^{-1/3}$$

where K is a constant depending on the roll-speed ratio. Bergau[8] has also written on roll crushers and has shown a way of correlating efficiency with roll clearance and a method of calculating efficiency.

Jaw crushers, gyratory and roll crushers

A new idea for a jaw crusher is one in which the crushing plate is part of a movable belt.[9] The downwards movement of the crushing links serves to rotate the charge to successive crushing positions as it passes between the nip of the jaws. A type of horizontal jaw crusher[10] has been described in which rock is fed on to an anvil and is crushed by the reciprocating action of a spring-loaded open frame working above it. To limit the crushing effort to small particles and to confine the nip to the bigger pieces in a new jaw crusher,[11] both jaws reciprocate and the liners are provided with buttress-type teeth. Oscillating or swinging the jaws of crushers[12, 13, 14] about a mean vertical position helps to speed crushing.

Gyratory crushers have received some attention in patent literature. The severe shocks received by these machines in the course of their duties call for special attention to the bearings and mountings.[15–18]

With crushing rolls, of course, the important feature is to regulate the gap with accuracy and firmness.[19, 20] Today, hydraulic controls are used on bearing pedestals.[21] Feed regulation—the next essential with crusher rolls—is helped by the shaking grizzley mounted above the rolls claimed by Sloane.[22]

Toothed roll crushers are frequently employed for the primary crushing of coal, and one recent form[23] has rollers of different diameters fitted with curved crusher plates adjustably mounted so as to regulate the size of the final product. At the Nantgarw Colliery, South Wales, a Pennsylvania single-roll crusher is used to reduce the raw coal to –4 in.[24] This crusher can be reset to give a product of –2 in. when necessary for the coke ovens. The Bradford-type breaker still has its adherents who will be interested in a new feed deflector[25] which fits inside the cylindrical drum and helps in the screening of the crushed product.

Hammer and impact mills

The hammer mill is steadily becoming 'a maid of all work' in the preparation of intermediate-sized particles. It provides a compact unit giving high output and can usually be made in a totally enclosed form so as to reduce the dust nuisance and explosion hazard. One convenient form[26] comprises, in tandem, a disintegrator-rotor-cum-peg-disc, the whole mounted in one case which can be swept with hot air. Another air-swept mill of advanced design was invented by Forth.[27]

The hammer mill is particularly adapted for use with screens which can sometimes be quickly changed without interruption of mill operation.[28, 29] This device can be particularly useful when crushing chemicals or agricultural products when a range of finished sizes are required from the same basic material. One new form of comminuting mill[30] built in stainless steel for use in the fine chemicals industry has rotor arms terminating in either a knife edge or a hammer face. The change from one to the other is made by reversing the direction of rotation of the rotor. A generous screening area is provided and interchange of the screens is accomplished in a matter of seconds. The speed of the mill is variable over a ratio of 5:1.

Spies[31] described a new German crushing and preparation machine suitable for use with coal. The feed is caught by a rapidly rotating horizontal rotor and is thrown against impact blades mounted within the machine casing. The parts subject to wear in this machine may be easily and cheaply replaced.

At the Achema XI Exhibition, Frankfurt, May 1955, a hammer mill[32] was shown which served the dual purpose of grinding and drying the coal dust ready for firing. Two forms of the mill were shown, one for hard coal and one for lignite.

Another German mill,[33] useful for clay shredding or pulverising, is a type of resilient impact mill in which the material does not come immediately into contact with the rotor but first enters an impact chamber. There it collides with the flying pieces of already crushed material and so is pre-crushed before being caught up by the impact blades. This is claimed to cause the material to fracture along its natural planes of weakness. One machine takes large lumps of clay and reduces them to pieces below 1¼ in. diameter at the rate of 20 to 50 tons/hr. For stone crushing, a double-rotor-type hammer mill has been improved[34] by baffle strips to feed the material properly into the pivoted disintegration hammers. Air-swept mills have received attention, particularly from the aspect of stock feeding methods.[35–37]

[Herbert Alexander & Co. Ltd.

This electrically driven mortar grinder was developed for laboratory use. It was proved in trials in a refractories laboratory where its performance with very hard materials was exceptionally good. The pestle head speed is 96 r.p.m. and the mortar 32 r.p.m. The agate mortar, volume 5½ cu. in. (90 c.c. cm.), is secured in a hardwood holder, mounted eccentrically to the pestle. The machine measures 19½ in. long, 10½ in. wide, 18 in. high and weighs 80 lb.

Pin-disc and peg mills

The continuous grinding of paper pulp or wood-fibre pulp is accomplished in a mill comprising pairs of discs mounted as a common rotor shaft.[38] The slurry passes through the machine *via* the numerous disc cutters. Other new pulverising equipment suitable for air-borne friable substances have been claimed.[39, 40] British patent literature makes reference to technical improvements in coffee grain and cereal crushing.[41–43]

Cronan[44] described a 27-in. impact mill which is virtually a horizontal

pin-disc mill mounted above a cyclone. The pins are vertically mounted on the periphery of a rotor which moves in close proximity to, but with a small clearance between it and the fixed vertical pins in the casing. Coarse particles fed at the centre of the disc are flung at high speed against the pins and the fines stream through, carried by an air blast into the receiving hopper beneath. When the pins become worn they may be rotated a quarter turn so as to present a new surface to the impacting solids. The pins may be of steel, stainless steel, bronze or carbide compositions. The peripheral speed of the rotor, at 3,850 r.p.m., is 28,000 ft. min. and at this speed the unit will deal with resinous substances without gumming up. For this reason, the unit is suitable for pulverising polyvinyl chloride. It will also defibrate short staple asbestos without degrading the fibres.

Modifications to peg mills have been claimed by several British patents.[45–49] One interesting form of peg mill[50] has two rotor discs mounted vertically and moving at high speeds in opposite directions. The stock is fed to the centre of the rotor between the two pegged discs and the crushed material becomes air-borne and is collected in enlarged peripheral chambers surrounding the mill.

Centrifugal mills, roll crushers, etc.

Pan mills, centrifugal mills, pendulum roller mills, ring roller mills and ball mills are descriptively illustrated in a general article by Waganoff,[51] and Mann has claimed an improved conical roller tyre for a pan mill.[52] The ring-roll mill is well known in this country because of its widespread application to pulverised coal installations. The *Rema* ring mill[53] is made in seven sizes, each of which can be fitted with different widths of ring and roll to meet crushing requirements with coals from the soft lignites to anthracite. Outputs range from 200 to over 12,000 lb. hr., depending upon size of crushing unit chosen. Of some interest is an article by Pfeiffer[54] in which he describes a triple-roller ring mill where each of the grinding rollers is supported by a single pressure spring so that only the upper grinding roll is driven. The stock is fed to the two lower rolls from each side.

Fine grinding

Ball mills are particularly adaptable to closed-circuit grinding, which is desirable when powdering coal. They work well in continuous circuit with cyclone air separators. Since the ultimate fineness of the powder produced is governed by the air separator, the flow of material through the mill need not be restricted. Overgrinding need never occur, since the particles are removed instantly they arrive at the predetermined size. Thus ball mills on closed-circuit duty operate at low power and give maximum outputs.[55] A mill of 96-in. diameter will produce some 15 to 20 tons/hr. of pulverised bituminous coal and consume only 300 h.p.[56] It is possible to increase the powder-carrying power of the air passing through a ball mill by directing it as a jet[57] on to a selected area within it. Another device for returning oversize material to the mill and separating it from the air-borne crushed particles consists of a deflector pipe and bucket elevator.[58] The shell

[Fremier Colloid Mills Ltd.

This 3-in. 'Multipurpose' mill was exhibited at the Oil and Colour Chemists Exhibition in London this year. With its two-speed motor, it can be used either for pulping fibrous vegetable matter and animal tissue or for grinding slurries or pastes. For the defibrating application, carborundum working surfaces are used and for paste grinding, stainless-steel rotors are available.

of an air-swept mill must be carefully sealed at bolt holes, particularly at points of attachment of the liner plates.[59]

Although ball stock in conical mills remains surprisingly uniformly graded along the length of the mills, it is usually necessary to segregate ball sizes by means of partitions when operating cylindrical mills[60] or by means of helical grooves cut in the liner.[61] Larin[62] has studied ball mills with side discharge and finds that this type works best at a high speed, the cascading balls grinding mainly by attrition. In this work, the optimum charge of balls and grist were 10 to 12 and 15% of the mill volume, respectively. Andreasen[63] arrived at similar conclusions by working with geometrical models and the like. Practical studies of cement grinding[64, 65] have shown that nickel-hardened steel balls were superior to balls of plain carbon steel.

Several practical studies of ball mill operation have been made[66–68] when crushing coke, coal and cement. The Taconite iron ore from the Mesabi Range, U.S., is crushed first in rod mills and finally to 325 mesh in ball mills.[69]

The Steel-Shaw laboratory mills have been well received and the large (10-gal.-capacity model) is now welcomed.[70] It is claimed to grind and disperse a charge of colour pigment in a clay medium in one-tenth the time normally taken by an orthodox pebble mill. The machine will mill materials wet or dry and finds a wide range of uses in the experimental manufacture of paint, ink, cosmetics, enamel frit and foods. Another multi-duty porcelain grinding pot mill has been described which again can be used wet or dry[71] for a variety of batch grinding operations. A new mechanical pestle and mortar designed to take the 'grind' out of grinding occupies only 15 in. × 10 in. of bench space.[72] It can be supplied with interchangeable mortars and pestles made of porcelain, tool steel or agate to suit the needs. Improvements in the mechanical arrangements attaching to wet grinding mills are claimed.[73, 74]

Vibratory ball mills or mills having more than one plane of rotation are interesting. These have been developed to overcome the limit set by 'centrifuging velocity' which is a critical top speed with conventional mills.[75–77] With improvements in bearings and mechanical arrangements these mills should become even more popular than at present and be made in even larger sizes.

Langharne[78] stressed the importance of adopting heavy grinding balls for the grinding of vitreous enamel frits. High-density media are non-metallic alumina pebbles of specific gravity 3 to 4.2 which are used instead of porcelain balls. In practical trials, it was demonstrated that with cover-coat enamel high-density media reduced milling time by 25 to 35%, resulted in no greater lining wear and appreciably less ball wear than when using porcelain balls. Alumina balls were used in a porcelain jar mill by Carruthers and Gill[79] to establish that the degree of aggregation of calcined alumina was very dependent upon the previous history of the batch even after prolonged ball milling. For preparing

glazes and frits, Hansard[80] advocates a mill having, as milling elements, vitrified alumina 'stones' which he claims has the advantages of economy, no foundations required and little contamination of the product.

Grinding and mixing are often carried out in simple drum-like rotating containers; new, however, is the idea of classifying the product in the drum by means of an air jet.[81] A conical drum mill for clay preparation has been described. It is claimed to combine in one unit all the operations necessary to condition clay for the potter.[82] For the preparation of wood pulp, a novel mill is proposed,[83] this comprising a drum mounted over a horizontal roll so as to form a 'nip' upon its upper surface. The pulp is fed in by a screw feed at one end and, after centrifuging through the plane of contact of the roll and the drum, it progresses spirally to the discharge end. Blade-type dispersion mills suitable for liquid suspensions are also of interest.[84, 85] A crushing unit for wood pulp is claimed[86] comprising a two-stage pulveriser in the form of a double drum in which are mounted horizontal rotor shafts, one having a screw and the other blades.

Fine roll and fluid energy mills

Roller-type flour mills may be fitted with a pneumatic discharge material conveyor which sucks off the ground-flour at a point just below the rollers.[87] Another flour milling scheme is described in patent literature[88] in which the whole of the fines are removed from the base of the mill to be classified in a separate pneumatic system. Flour milling is, of course, an art which is being gradually subjected more and more to scientific control. The pressure on the grinding rolls must be controlled to suit the atmospheric conditions, and this can now be accomplished automatically.[89] Other flour mill inventions are recorded,[90, 91] and Nanta[92] has claimed a scheme for the grinding of a blended mixture of cereals, the final product being delivered ready for the bag.

The popularity of the fluid energy mill appears to be on the increase. The solids to be pulverised are entrained in a current of air and comminution results by the continuous collison of the particles.[93] One new fluid energy mill[94] comprises a cyclone into which the solids suspended in air at high velocity enter and from which the stream emerges under strong suction induced by a vacuum pump. Another form[95] has two opposing jets, one stronger than the other. Energy is absorbed in the crushing of the airborne particles and the resultant flow of air takes the dust around a horseshoe ducting and, at a convenient point, separation of the fines is arranged; the oversize being recycled. A centrifugal pulveriser especially suitable for coal crushing utilises the carrier air for the simultaneous disintegration of the particles and classification.[96] Kaolin may be crushed to particles less than 2 microns[97] and yet retain a plate-like form by crushing in a fluid energy mill.

Special applications

Synthetic resins of the polythene or PVC types are frequently marketed to extruders in the flake form, which can be cut transversely from rolled profiled ribbon having longitudinal ribs which project alternately from each of its surfaces. This ribbon is made by passing the synthetic material through grooved rolls.[98] Another method[99] for granulating plastics is by shearing flakes from the slab whilst in a doughy condition and sweeping them along in a stream of air until the particles are cold and hard.

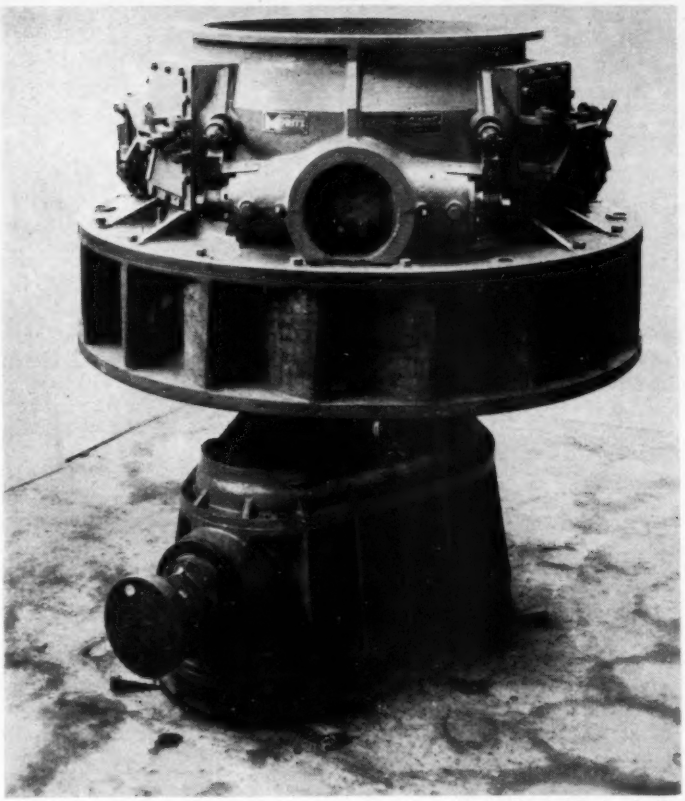
Metal powders are frequently required to have a flake form so that they may be usefully employed as pigments in paint films. This particle form is produced when suitable metals like aluminium are crushed in a miniature rod mill.[100] Static electricity which sometimes builds up during metal crushing may be dispersed by a method patented by Bernard.[101]

To break down fibrous material and yet retain a fibrous structure in the fine product is always a problem and a method of performing this operation has been described.[102, 103] The machine is a type of hammer mill in which the rotating cutters or hammers rotate on a vertical shaft and the crushed material is swept from the mill by a current of air. Where the fibrous material, like jute or flax, is required to have as long a staple as possible, the problem is to separate them without cutting the fibres short. One method is to suspend the fibres in a fluid stream and to repeatedly bend them in the decorticating zone of the machine.[104] Another comminuting apparatus in which the material to be disintegrated is carried through the equipment in suspension has been claimed by Borner.[105] For grinding waste food and domestic refuse, Powers[106] described a self-contained disintegrator unit which could be attached to the kitchen sink and which automatically switched itself on or off, depending upon the presence of water flowing through the waste pipe.

Finally, mention should be made of a patented process of subjected granular solids to the exploding action of detonated gases.[107] The pulverised materials are passed off from the combustion chamber with the combusted gases and scavenging gases.

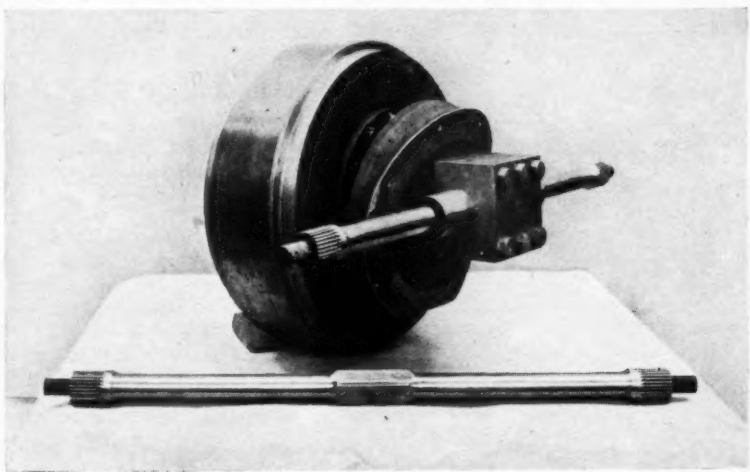
REFERENCES

[1] 'The Mining and Dressing of Low-Grade Ores in Europe,' O.E.E.C., Paris, 1955.
[2] G. F. Huttig and H. Sales, Powder Metallurgy Symposium, Iron and Steel Institute, London, December 1, 1954.
[3] H. Lehmann and U. Haese, *Tonindustrie Ztg.*, 1955, **79** (7-8), 91-94.
[4] T. Tanka, *Chem. Engg.* (Japan), 1955, **19**, 152.
[5] A. Baouman, *Industr. Chim.*, 1955, **42**, 209.
[6] V. A. Baouman, *Mech. Constr.* (Moscow), 1954, **2** (7), 21.
[7] *Ind. Engg. Chem.*, 1955, (4), pp. 696, 701, 703.
[8] G. Bergau, *Ziegelindustrie*, 1954, **7**, 962.
[9] U.S. Pat. 2,736,503.
[10] U.S. Pat. 2,735,627.
[11] U.S. Pat. 2,707,081.
[12] U.S. Pat. 2,721,036.
[13] Brit. Pat. 724,883.
[14] U.S. Pat. 2,718,358.
[15] U.S. Pat. 2,713,461.
[16] Brit. Pat. 739,348.
[17] U.S. Pat. 2,701,107.
[18] U.S. Pat. 2,699,900.
[19] Brit. Pat. 739,948.
[20] U.S. Pat. 2,736,504.
[21] Brit. Pat. 738,163.
[22] U.S. Pat. 2,734,688.
[23] Brit. Pat. 725,477.
[24] B. A. Price, *General Electric Companies' Journal*, April 1955, **22** (2), 105-116.
[25] Brit. Pat. 724,467.
[26] U.S. Pat. 2,699,898.
[27] U.S. Pat. 2,732,138.
[28] U.S. Pat. 2,706,087.
[29] U.S. Pat. 2,732,137.
[30] W. C. Peck, *Chem. & Ind.*, March 10, 1956, pp. 157-163.
[31] Spies, *Colliery Guardian*, 1954, **189**, 382-383.
[32] CHEMICAL & PROCESS ENGINEERING, 1955, **36** (4), 138.
[33] *Euro-Ceramic*, 1955, **5**, 95.
[34] Brit. Pat. 737,253.
[35] Brit. Pat. 727,212.
[36] U.S. Pat. 2,734,686.
[37] Brit. Pat. 724,336.
[38] U.S. Pat. 2,730,931.
[39] Brit. Pat. 726,075.
[40] U.S. Pat. 2,732,136.
[41] Brit. Pat. 725,532.
[42] Brit. Pat. 739,229.
[43] Brit. Pat. 739,246.
[44] C. S. Cronan, *Chem. Eng.*, 1955, (10), 256-258.
[45] Brit. Pat. 725,863.
[46] Brit. Pat. 726,714.
[47] Brit. Pat. 726,715.
[48] Brit. Pat. 739,615.
[49] Brit. Pat. 726,242.
[50] U.S. Pat. 2,712,416.
[51] N. P. Waganoff, *Tecn. Industr.*, 1954, **32** (4), 229-302.
[52] Brit. Pat. 726,607.
[53] *Edgar Allen News*, April 1955, **34**, 82-83; June, 126-127.
[54] H. Pfeiffer, *Silikat Tech.*, 1955, **6**, 177.



[Moritz Chemical Engineering Co. Ltd.

The Moritz roller-type B.G. 12 grinding mill is suitable for the fine grinding of barytes, lime, gypsum, dolomite, pigments, coal, sulphur, coke, lithopone, graphite, marble, titanium oxide, iron oxide, felspar, phosphates, etc. It takes raw material



of 20% moisture and gives a dry product to a fineness of down to 300 mesh. Its rollers, supported by a patented torsion bar, rotate at different tangential speeds, thereby grinding by a combination of pressure and friction.

[55]*Edgar Allen News*, Feb. 1956, **35**, 29-30; March, 52.
[56]*Ibid.*, May 1955, **34**, 100-101; June, 126-127; July, 152-153.
[57]Brit. Pat. 740,364.
[58]U.S. Pat. 2,712,902.
[59]U.S. Pat. 2,706,656.
[60]Brit. Pat. 725,513.
[61]Brit. Pat. 739,578.
[62]A. P. Larin, *Ogneupory*, 1955, **20**, 195.
[63]A. H. M. Andreasen, Trans. Fourth International Ceram. Congress, 1954, p. 121.
[64]*Rock Products*, 1955, **58** (10), 136.
[65]*Nickel Topics*, 1955, **8** (10), 10.
[66]*Chem. Eng.*, 1955, (12), 252.
[67]J. Taylor, *J. Inst. Fuel.*, May 1954, **27**, 249-254.
[68]F. Kraus, *Zement, Kalk, Gips.*, 1954, **7** (7), 273-281.
[69]*Genie Civil*, Aug. 15, 1954, pp. 313-314.
[70]*Ceramics*, Aug. 1955, p. 276.
[71]*Ibid.*, Feb. 1955, p. 557.
[72]Shandon Scientific Co. Ltd., 'Laboratory Practice,' July 1955, p. lxxxvii.
[73]Brit. Pat. 725,513.
[74]V. M. Deryngin and F. M. Ivanov, *Mech. Constr.* (Moscow), 1954, **2** (7), 19.
[75]Brit. Pat. 730,494.
[76]U.S. Pat. 2,727,697.
[77]U.S. Pat. 2,713,976.
[78]G. Langharne, *Inst. Vitreous Enamellers' Bull.*, Jan. 1956, **6** (3), 73-81.
[79]T. G. Carruthers and R. M. Gill, *Trans. Brit. Ceramic Soc.*, 1955, **54** (2), 69-82.
[80]W. C. Hansard, *Bull. Amer. Ceram. Soc.*, 1955, **34**, 115.
[81]Brit. Pat. 737,203.
[82]*Euro-Ceramic*, 1955, **5**, 94.
[83]Haug Kollermill, *Kvalitet* (Norway), June 1955, (48), 594-600; E.P.A. Technical Digest No. 468.
[84]U.S. Pat. 2,706,721.
[85]Brit. Pat. 739,982.
[86]U.S. Pat. 2,734,685.
[87]U.S. Pat. 2,717,124.
[88]U.S. Pat. 2,713,977.
[89]U.S. Pat. 2,713,460.
[90]U.S. Pat. 2,734,687.
[91]Brit. Pat. 744,611.
[92]Brit. Pat. 741,403.
[93]U.S. Pat. 2,735,626.
[94]U.S. Pat. 2,698,718.
[95]U.S. Pat. 2,704,635.
[96]Brit. Pat. 740,632.
[97]U.S. Pat. 2,726,813.
[98]Brit. Pat. 725,973.
[99]U.S. Pat. 2,726,045.
[100]Brit. Pat. 724,438.
[101]U.S. Pat. 2,733,866.
[102]U.S. Pat. 2,700,511.
[103]U.S. Pat. 2,700,512.
[104]Brit. Pat. 739,611.
[105]U.S. Pat. 2,726,046.
[106]U.S. Pat. 2,700,509.
[107]Brit. Pat. 729,596.

Water testing (B.S. 2690: 1956, 17s. 6d. net). When standard methods for the physical and chemical examination of waters used in steam generation were first proposed it was suggested that three groups of methods would be required. The first of these groups, already issued as B.S. 1427, describes tests which can be made even when ordinary laboratory facilities are not available. The present standard, while it includes some of the tests already given in B.S. 1427, consists mainly of tests which require laboratory facilities and call for chemical training, and during its preparation it became evident that the third group, intended to serve research workers, would be of little use. Many of the methods in the present standard are directly applicable to research problems, and instances where special methods have to be devised would be of limited application.

Commissioning a New Chemical Plant

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The starting up of a new chemical plant requires careful planning and must be carried out in a number of successive steps. The author has reviewed the various tasks involved and offers these notes as a guide for managerial staff who may be faced with the problem of commissioning a new plant for the first time.

A CHEMICAL plant superintendent has to handle four basic requirements for every process:

(*a*) Raw materials.
(*b*) Services.
(*c*) Labour.
(*d*) Plant.

The correct planning and co-ordination of all four is commenced long before a new plant goes 'on stream.' If a new works is being built and commissioned, the planning can become very complex. It is assumed here that a single new plant is being installed on a developed site. For simplicity's sake, it is further assumed that the process has previously been operated on at least the pilot-plant scale. The work to be done will be reviewed under successive headings.

Early precommissioning period

By the time design work is complete, the construction of the plant will have commenced. About this stage, a plant manager is appointed, and he will be associated with the recruitment of a junior graduate to act as assistant. Several foremen will also be selected if the plant is to operate continuously on a shift basis. Nowadays, the chemical plant foreman is often required to have undergone technical training to the National or Higher National Certificate level. The specialised training of the supervisory personnel can commence at this stage. If possible, they should assist in the running of a similar plant, or perhaps a pilot plant, for several weeks, on a daily or shift basis. This is also the time to consider placing the younger, less experienced people on T.W.I., or 'Training Within Industry' courses, so that they may learn the basic principles of handling labour.

The plant manager should read the contract, and study it to see if there are any gaps in responsibility.

This is the period during which data manuals should be prepared. These will be concerned with the nature of the raw materials and the products of the plant. All levels of supervisory staff should be made to assist in this job. The following list is a guide to the contents of these manuals:

(1) Chemical and physical properties of materials.
(2) Safety features, including inflammability, toxicity, antidotes and safety appliances.
(3) Storage, handling, packaging and transport.
(4) Ventilation.
(5) Effluents.
(6) Servicing features; corrosion data.

The plant manager and his deputy should from time to time give talks on the simple chemistry of the process to be operated. The physical processes involved should also be explained. All supervisory personnel, down to and including junior foreman, will appreciate the care taken by graduate staff in explaining clearly the general principles involved. At a later date, process workers will be taught the principles of operation of such equipment as flowmeters, pumps and filters. It will be useful, therefore, to prepare large diagrams in bold outline during this pre-commissioning period, so that they will be ready for use at a later stage when there is less time available.

Attention should be given toward building up the team spirit *before* the foremen go on shift—because it will then be very difficult to hold meetings with all the supervisory staff in attendance.

Frequent meetings held during the pre-commissioning period will also be useful for developing safety consciousness. The supervisors must realise that they will not receive medals for increased production or efficiency if they put men in hospital while doing so! Lectures on safety should be arranged, so that the team can learn the necessary first aid and the use of safety equipment and any protective clothing which might be used in operating the process. Special medical facilities may have to be arranged, particularly if toxic materials are to be handled. Short talks on the Factory Acts and the Chemical Works Regulations, with particular reference to the type of plant concerned, would also be helpful, if time permits.

During this early period, the plant manager, assisted by his deputy, and perhaps also the plant engineer, who will probably be appointed about this time, should compile a process operating manual. Such a manual is sometimes provided by the contractor in the early stages, but this may need revision in the light of growing experience. It should describe the plant in some detail and also give clear instructions for carrying out every operation necessary for start-up, the daily running of the process, and for shut-down, including emergency shut-down. The plant engineer will be particularly responsible for preparing a supplement on plant maintenance schedules. Specimen daily operating log sheets should also be appended to the manual.

Late precommissioning period

While installation of the plant is being completed, the supervisory staff will start to pay visits. This will be a nuisance to the contractors, but is unavoidable. Tact and courtesy on the part of the operating team is therefore essential for the maintenance of good relations. Top management can make a major contribution toward developing good '*esprit de corps*' at all levels. At this stage, the chargehands and leading hands should be made available, and recruitment of process operators begins.

A supply of flow diagrams should be to hand. These should be clear, single-line piping layouts, readily intelligible to all supervisors and chargehands. Everyone from chargehand and leading hand upwards should trace out for themselves the location of every pipe, vessel and valve, together with the instruments of the plant. It is a good plan to go over the lines on the diagram in *colour* (each colour corres-

ponding to the actual plant colour code) as the various items are traced out. The value of this search is two-fold—it enables the staff to get to know their plant, and it also serves to find any mistakes made by the contractors.

It is also permissible at this stage to make practical suggestions for improvements. Obviously, no major changes in plant design or layout can be made, as this would cause confusion, and hence delay in the completion of the contract. However, small local alterations can be made, if these are few in number. A valve may be inaccessible; a piece of plant may not have adequate isolating valves; electric switches may not have free access. A good contractor will understand that some modifications are inevitably found necessary when two-dimensional plans are translated into three-dimensional plants. The plant manager should make it quite clear to his supervisors, at an early stage, that intelligent suggestions are welcome from all ranks. Late modifications required by the customer should be fed into the contractors *via* one liaison officer, preferably the plant engineer, who will also arrange for the necessary 'paper work' to be cleared between the respective offices of customer and contractor.

Raw material supply

It is important to finish the construction of the raw material storage tanks as soon as possible, so that these can be calibrated, and stocks built up in anticipation of the start-up. The use of part of this storage capacity as a temporary buffer storage for intermediates, during commissioning only, may require the temporary addition of pumps and pipeline. Plans may also have to be made for obtaining supplies of inert gases, such as nitrogen, for purging out lines and vessels. Any other special materials for commissioning not normally required during plant operation will also have to be made available.

Fire fighting facilities, etc.

Fire brigade liaison must be established, and a way in to the plant for ambulance and trailer pumps agreed upon. If an effluent plant is to be operated as a necessary adjunct to the main plant, this may need to be commissioned prior to the main plant, unless considerable effluent storage capacity is available.

The plant manager should check at this stage, with his company's legal officer, that insurance cover is adequate for the commissioning period.

Systematic check

When the plant installation is finally complete, a systematic check should be carried out as follows:

(1) All joints and flanges should have been correctly made, bolts tightened and blanks removed (*e.g.* spectacle plates reversed).

(2) Lagging should be completed on steam lines, heated process lines and vessels, also refrigerant lines; except that flanges should be left exposed, so that bolts can be tightened up after heating/cooling cycles.

(3) Steam traps and condensate lines should have been installed.

(4) Electric motors should have guards, and be properly protected from water, dusts, etc.

(5) Pressure vessels (including vacuum vessels) should have been tested above their normal working pressure, and suitably vented (where do the relief valve outlets and bursting disc discharge lines go to?). Vacuum vessels to be evacuated, blanked-off, and the rate of rise of pressure measured as a check on leak-tightness. (The permitted leak rate should be specified in the contract.)

(6) Means of lubrication should have been provided wherever necessary—grease cups, lubricated cocks, oil baths, etc.

(7) Illumination should be checked after dark.

(8) All instruments should have been installed correctly, and electrical or pneumatic lines to the instrument panels connected up.

(9) Every plant vessel must be inspected—the manhole cover should be removed if necessary—in order to check for the complete absence of oddments such as nuts and bolts, packing materials, straw, washers, etc.

(10) The plant laboratory should have been fitted out, glassware and chemicals supplied and personnel should be experienced in carrying out the necessary routine analytical control methods (these should be fully described in the process operating manual).

(11) Safety notices should be in place; fire extinguishers and protective clothing on the plant in handy places. Antidote bottles should be freshly filled, breathing equipment brought in and all exits cleared (the bonding should be checked on 'flameproof' plants).

(12) The maintenance team should learn any special maintenance techniques, under supervision by the contractors' representatives (*e.g.* special welding techniques).

Starting up the plant

Stage 1

All services should be commissioned. Careful planning and co-operation with outside people may be necessary. Water, including mains and cooling supplies, should be turned on. Electric power lines switched on, and all motors and pumps run up to speed. Trips and safety cut-outs should be checked. Compressed air supplies must be turned on. Instruments can be checked perhaps by admitting steam, and pressure points by compressed air or even water. Interconnecting pipelines with other plants will also be commissioned at this stage. Emergency shut-down procedure should be rehearsed. All personnel should be thoroughly briefed in preparation of the next two stages.

Stage 2 'Dummy runs'

If the plant is to be operated on a 24-hr. basis, the management should be organised on a shift basis for the duration of stages two and three, which may last several weeks.

The plant engineer might take charge of one shift, the assistant plant manager a second shift and the plant manager himself will control the remaining shift. (Weekends will not be different from the rest of the week!) A plant log book will be started; the right-hand page to be a *summary* of the shift's operation, written by the supervisor, and the left-hand to be used for written instructions.

Complete dummy runs will be carried out, using water as a stand-in for an aqueous process, or perhaps compressed air or nitrogen for a gaseous process. In the atomic energy processing plants, natural uranium can sometimes be used as a stand-in for enriched uranium or plutonium. The requirement at this stage is for a stand-in which is cheap and comparatively non-hazardous in the event of leakage or spillage. Considerable thought will have been given at an early stage concerning the selection of a suitable fluid.

If a non-aqueous liquid process is to be operated, care should be taken to dry out the plant after the dummy runs if water has been used as the stand-in. The problem of 'heels,' or residual liquid in process vessels which do not drain completely, may be difficult. It may be found necessary to carry out engineering modifications as a result of the experience gained, and these will have to be completed, followed by further dummy runs, prior to the next stage. Key maintenance craftsmen should be on shift, so that work

can proceed continuously; electric welders, electricians, pipe fitters and instrument artificers are the main types required.

Stage 3 First product runs

The product storage tanks or containers should previously have been made ready. If the product is inflammable, the holding vessels should be filled with an inert gas such as nitrogen.

Plants which are to be operated under automatic control will first be started up manually; operators will have to satisfy themselves that the instruments are functioning correctly before leaving any section of the plant 'on automatic.' Observation of the recorders over a complete cycle of operations is therefore necessary. Only the first stage of the process will be commissioned initially, and an analysis of the intermediate product will be made and the result carefully examined before proceeding (the plant should have adequate intermediate stock tank capacity, to give flexibility in operation). An allowance may have to be made for analysis taking a long time to complete, until the laboratory has settled down to a daily routine. Other laboratories within the company may have to help out, or the contractor may give assistance with this work.

It is no use being impatient for full output from the plant; this will have to be attained by a progressive building up in output rate over a period of days or perhaps weeks. The local management may have to be firm on this point in their dealings with senior executives, who will probably be pressing hard for deliveries of finished product the day after the plant is due to start up!

Frequent changes in plant operation should not be made without giving due consideration to the kinetics of the reactions involved. The time required for continuous plants to reach equilibrium varies considerably.

After a period of running, it may be advisable to shut down completely to give the engineers a chance to rectify important defects. If this is done, it will be necessary for the plant supervisors to check once more that lagging has been replaced, joints correctly re-made, etc., etc.

The first 'runnings' from a continuous process (or batches from an intermittent process) may be high in iron content or other impurities until the plant has become passivated or run in. Such material may have to be stored for reprocessing, or kept for blending off with fresh product at a later date. A final check of the specifications should be made at this late stage to see if any recent alterations have been made concerning quantity and quality.

Finally, it is a sound plan to arrange a meeting to discuss the experiences of the first few months' operations with the research chemists and design engineers. The latter personnel may be able to offer constructive advice if the plant is not operating according to schedule. Alternatively, the plant manager and engineer may be able to give practical suggestions which will influence the design of new plants of a similar type.

Conclusions

It will be evident from the foregoing that the commissioning period is a very busy time for the plant manager and his supervisory staff. Much involved planning is called for. Although the normal supervisory staff will include graduates, these may have little time or mental energy left for high-level technical thinking, and many large companies therefore reinforce the plant staff at this time by loaning professional technologists from a development group or a central pool. The latter type of person merely functions as a 'trouble shooter' during commissioning; the method of approach required for this work was the subject of an earlier article by the author in CHEMICAL & PROCESS ENGINEERING, 1955, **36** (2), 41-44.

Acknowledgment

The author wishes to record his thanks to Mr. R. G. Tongue, of W. J. Fraser & Co., for helpful discussions and advice in the preparation of these notes.

Simplified Production of Improved Polyethyl

The production of polyethyl polymers is normally accomplished under extremely high pressure, up to approximately 2,000 atm. and at temperatures of 200°C. The resulting high production costs and the low heat resistance—polyethyl produced in this way softens at approximately 70°C.—have limited the use of polyethyl to a very narrow range in spite of its valuable properties.

In the course of the last three years, German scientists have succeeded in developing a process for the polymerisation of ethyl to the point where it can now be industrially exploited. Transfer from laboratory to industrial plant in the proportion of 1: 1,000 was accomplished. The process is based on the principle of combined catalysts from compounds of two different metals (aluminium-alcyl and titanium-tetrachloride) and permits polymerisation under normal atmospheric pressure and at usual room temperatures. Even cooling is necessary in order to prevent undesirable acceleration due to an increase in the temperature caused by the reaction heat.

After a considerably shorter time than hitherto required, the polymerised polyethyl can be rinsed with alcohol; its granular form facilitates further treatment.

Research in connection with this process has advanced so far that one can determine in advance the molecular weight of the polymers within the wide range of 10,000 to 3 million. This makes it possible to produce molecules between 50,000 and 100,000, which are preferred in industry or, if certain specified properties are requested, to produce the corresponding high-mol. sizes which was not possible until now. The properties can be varied in an hitherto unequalled manner. Threads made from 'normal-pressure polyethylene' have *e.g.*, 40% of the stability and tear strength of *Perlon*, an accomplishment not believed to be attainable in the past. The fact that the shape remains consistent even at temperatures of 110°C., makes it possible to boil and sterilise containers. This is a technical improvement considerably widening the field of application. In this connection it is particularly important that manufacturing costs of the improved polymers are at least 30% below those of the usual product, while the manufacturing time is also considerably reduced.—*E.P.A. Digest from: Industriekurier, 'Technik und Forschung' (Germany)*, 1955 (182), p. 488.

Control gear is featured in a catalogue from Square D Ltd. It features multi-pole relays, motor starters, push-button units, limit and pressure switches, timing relays, thermal overload relays, voltage testers, etc.

Recent Developments in RUBBER LINING

By R. F. Reynolds, A.R.I.C., A.I.R.I.

Advances in the use of rubber linings for tanks, vessels, pipes and various other items of chemical plant are surveyed, with a discussion of the composition of these linings, the effects of the linings on process liquors, and the use of synthetic rubber and plastics. Finally, a pointer is given to future trends.

SINCE the early 1920s the use of natural rubber in one form or another as a protective lining or covering for chemical plant has steadily expanded. This expansion is due partly to that of the chemical industry itself and partly to the improvements in technique that have been developed by the rubber industry and its ancillaries. A degree of scarcity and costliness of one of the chemical industry's traditional materials—lead—particularly during the years following World War 2, also made a contribution to the increase in the use of rubber, for example in processes involving sulphuric acid under the milder conditions of temperature and concentration.

The scarcity of stainless steels and the fact that even they have corrosion difficulties have prompted enquiries about rubber-lined or covered alternatives and for the rubbering of the stainless-steel equipment itself. A deterrent in this latter connection is the lack of a really good adhesive system for bonding the rubber to the stainless steel.

Early tank linings were made on separate formers and fitted loosely into the tank to be protected. In other cases, owing to limitations in technique, vessels were constructed in which the rubber lining was left unvulcanised. From these truly pioneering efforts through the stage of thermoplastic adhesives for adhering rubber to metal, the modern lining has been developed, fully vulcanised and bonded to metal or to wood in such a way that adhesion remains effective under vacuum and at temperatures even higher than it is prudent to subject the rubber to if good service life is to be obtained.

An awkward pipe junction successfully lined with rubber.

Adhesives

The adhesives used are based on chlorinated rubber, on triphenyl methane tri-isocyanate, on mixtures of chlorinated rubber with organic isocyanate and on vulcanisable compositions of rubber hydrochloride. They are suitable for bonding rubber linings, either natural or synthetic, on to mild steel, cast iron, brass, some bronzes and copper itself, but less conveniently to aluminium alloys and other metals.

Chlorinated rubber-based adhesives will adhere to wood and by the use of a self-vulcanising rubber composition (that is to say, one which will vulcanise at atmospheric or slightly elevated temperatures) wooden launders and vats can be successfully lined. Concrete vessels are lined with similar rubber compositions but using either a thermoplastic rubber adhesive or a mixture of stabilised rubber latex and cement to adhere them to the vessel walls. Adhesion to concrete under some circumstances, however, is not regarded as wholly adequate and in some recent installations it has been deemed advisable to supplement the anchorage with bolts and washers.

Composition of rubber linings

The rubber chemist has now at his disposal a variety of accelerators of vulcanisation and vulcanising agents enabling rubber to be vulcanised under a wide range of conditions.

Compositions are available that will vulcanise at atmospheric temperatures during a period of a few days to several weeks; in 3 to 10 hr., for example, at 80 to 100°C. (hot air or hot water) and in ½ to 1 hr. at 150°C. under steam pressure.

Thus the advantages of rubber linings may be extended to vessels whose size, shape or construction renders them unsuitable for pressure steam vulcanisation.

Many chemical processes including metal pickling, electro-plating and digestion of minerals are carried out at elevated temperatures and the resistance of rubber to the deteriorating effect of heat is an important factor in determining its useful life as a

lining. As is well known, rubber is vulcanised by cross-linking the polymer chains, usually with sulphur, and it was discovered by experiment that retention, under conditions of dry or wet heat, of physical properties such as tensile strength, tear and abrasion resistance, as well as flexibility, is greatly improved when the amount of sulphur used in cross-linking is kept within the range 0.3 to 1.5% of the rubber hydrocarbon. Further resistance to the effect of heat is brought about by the incorporation of antioxidants such as aromatic secondary amines or their condensation products with ketones or aldehydes.

Apart from rubber and its accelerator/vulcanising agent system, a lining composition often contains powdered 'fillers' or reinforcing agents, the former serving as aids to the production of a smooth sheet exhibiting low shrinkage during vulcanisation and as an aid to cheapness and economy, the latter as means of improving resistance to cutting and tearing and some types of abrasion.

The need for ensuring that linings for use in acid should be as free as possible from acid-soluble fillers will be obvious and the avoidance of substances reactive to alkali such as vulcanised oils, ester plasticisers or amphoteric oxides is equally desirable in linings for use under strongly alkaline conditions. Nevertheless, rubber exerts a protective action on soluble fillers and, if present, they are extracted relatively slowly.

Carbon black, which may be introduced either as a filler or as a reinforcing agent according to type, is inert to both acids and alkalis as used in contact with rubber and, together with such obviously suitable fillers as barium sulphate, silica or kaolin, it has a further useful effect in reducing the amount of water absorbed by a rubber lining. Raw, unvulcanised rubber may absorb up to 20% of water, but when vulcanised this figure may be reduced to 5% or less. Addition of carbon and suitable fillers will reduce this figure roughly in inverse proportion to the volume added. In the case of water or other substances even more soluble in rubber—such as acetic acid and sulphur dioxide—suitably inert fillers reduce absorption and diffusion by their mass effect, thus adding further to the protective action of the lining composition.

In connection with this subject of the addition of fillers to rubber and rubber-like polymers, the development of a kaolin and wollastonite surface treated with certain quaternary ammonium salts (cationic surfactants) seems of interest. It is to be anticipated that, by the use of these 'organophilic clays,' compositions having better impact and abrasion resistance and improved hydrophobic properties may be produced, although this development as yet awaits exploitation in the rubber-lining field.

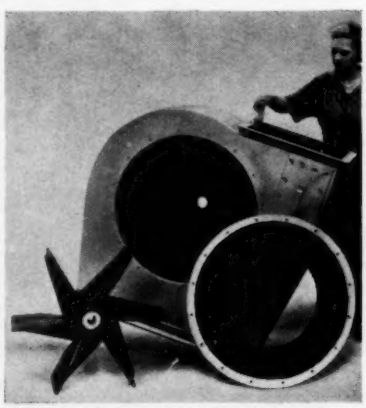
Rubber lining properties summarised

The modern vulcanised rubber lining therefore combines the advantages of secure adhesion to the base material (the bond is formed during and as a result of vulcanisation) with reduced swelling and permeability resulting from cross-linking of the basic polymer and from the barrier effect of inert fillers, together with the virtually non-thermoplastic property which is a further result of cross-linking.

Ebonite

When rubber is vulcanised with a much higher percentage of sulphur (30 to 50%) than is customary for soft linings, it is transformed into a thermoplastic substance variously known as hard rubber, vulcanite or ebonite, though this last term is greatly to be preferred as it clearly distinguishes between this material and 'soft' or flexible rubber.

Ebonite is more stable to chemical attack than soft rubber, but it is less resistant to abrasion. In rubber-lining work the type of abrasion most frequently met with is that caused by the impingement of particles (sand, grit or crystals) and it is the softest of the soft-rubber type of lining which gives the best performance. Even the pneumatic tyre tread compositions, supreme under conditions of road wear in which cutting and sliding friction are the destructive factors, give less satisfactory resistance to the impingement type of abrasion than soft rubber of about 40° Shore durometer hardness, and ebonite (95 to 100° Shore durometer) is less satisfactory still.



Rubber-lined extractor fan and housing.

An adhesive is not necessary for the bonding of ebonite linings to metal, since they show specific adhesion towards a clean surface and their rigidity also helps to maintain them in position. This, together with its good chemical stability, led to the early use of ebonite as a protective lining, patents being granted as long ago as towards the end of the last century and the beginning of the present one.

The disadvantages of ebonite, namely its low softening-point (60 to 70°C.) and its brittleness, have been only slightly offset by more recent developments. By partly replacing the natural rubber content by an appropriate synthetic rubber-like material, brittleness can be reduced with negligible sacrifice in chemical stability and the use of modern accelerators of vulsanisation combined with partial replacement of natural by yet other synthetic rubber-like materials raises the softening point so that service at temperatures of 85 to 90°C. can be obtained under favourable circumstances.

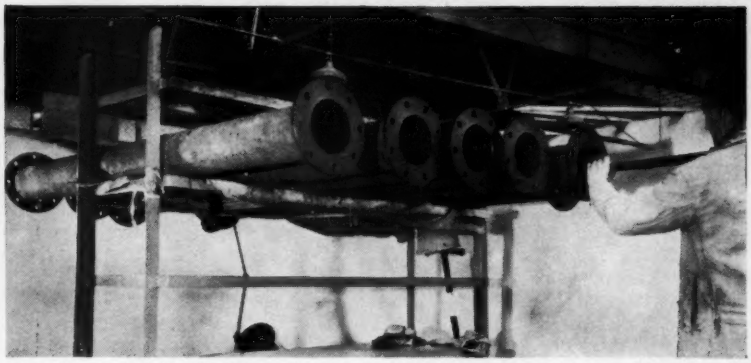
A more recent development is that of ebonite compositions capable of being vulcanised by means of hot water, thus permitting the lining of vessels too large or otherwise unsuitable for vulcanising by pressure steam.

Effects on process liquors

In some applications, particularly bright nickel plating, heavy copper plating and the phosphate coating of metals, soft linings interfere with the satisfactory operation of the processes as a result of the extraction from the lining of traces of chemicals—possibly accelerators or their thermal decomposition products formed during vulcanisation. Brown or black stains or 'smokiness' can result on bright nickel-plated articles and the deposit may be brittle. Similarly, heavy copper deposits may be made brittle and useless and electroplated lead develop dendritic growths. Evidently brittleness results from adsorption of the extracted chemicals on grain faces and growth orientation by preferential adsorption on some faces.

Although these effects largely disappear as the offending chemicals become removed by 'plating out' or by adsorption on activated carbon, appropriate ebonite linings do not suffer from this disadvantage and are

Rubber lining an acid storage tank.



The pipes being lined with rubber here are for conveying dilute sulphuric acid.

therefore preferred since the potential menace is absent and the conditioning process necessary with soft rubber—which may take several weeks—is dispensed with.

Rubber linings and foodstuffs

When rubber linings may come into contact with foodstuffs or beverages, the question of traces of extracted chemicals becomes a very critical one.

The sense of taste is not clearly distinguished, in practice, from that of smell and both are highly sensitive, at least temporarily. Besides being sensitive, the reaction of the individual to them is rather variable, being affected by his state of health and recent 'taste or smell history.' The difference between individuals is well known, but the variable reaction of one individual usually passes unnoticed and is best demonstrated under conditions not established during the normal circumstances attending eating and drinking.

Even so, the odour of recently vulcanised rubber, being due to traces of volatile sulphur compounds, including hydrogen sulphide, is generally unpopular and its aqueous extract can be anything from mildly unpleasant to almost intolerable. Therefore, it is not surprising that rubber starts off with somewhat of a handicap when its use with food or potable liquids is considered. Nevertheless, by the choice of suitable ingredients, free from strong taste or smell, and treatment of the lining with steam or hot water prior to using, it is possible to provide materials at least bland enough to merit submission as a basis for argument.

In spite of these considerations, rubber-lined vessels are being used for the storage of fruit juices, for their fermentation into mildly alcoholic beverages and for the storage of pectin used in jam making. The conveyance of corn syrup in rubber-lined road tankers is considered to be a feasible proposition.

A further consideration that should not be overlooked is that, although laboratory tests can easily be devised to demonstrate that rubber can convey an unpleasant taste to a liquid in contact with it, trouble may not be experienced on this account on the plant scale where the volume of liquid is large in relation to the surface area of the rubber in contact with it. In addition, the time of contact may be insufficient to extract enough material to confer taste. Such factors evidently contribute to the successful use of rubber-lined equipment in water-treatment plants.

Diffusion of chemicals through linings

By virtue of its far greater degree of cross-linking by sulphur, ebonite shows greater resistance to those chemicals which swell and penetrate soft rubber. Lower fatty acids and aldehydes are in this class and acetic acid is one that has commonly to be dealt with by ebonite if long life is to be obtained. Acetic acid even in low concentrations will penetrate $\frac{1}{8}$- to $\frac{3}{16}$-in.-thick soft rubber lining in two or three years and cause corrosion of a mild-steel vessel sufficient to destroy the adhesion of the lining and to evolve gas that will blister it away from the metal. Aqueous solutions of sulphur dioxide behave similarly.

Use of synthetic rubbers

Apart from the value of synthetic rubbers in 'water-curing' ebonite compositions and in reducing the brittleness of ebonite upon impact, where they are used in relatively small proportion to the natural rubber forming the base of the composition, important developments have taken place in recent years whereby lining compositions based entirely on synthetic rubber-like polymers are becoming increasingly popular.

Neoprene, the first synthetic rubber-like material to be commercially available, is useful as a lining material, having advantages in chemical stability, solvent and oil resistance over natural rubber. It has excellent resistance to the effects of air and sunlight ('weathering') and is appreciably less combustible than other rubbers.

Neoprene compositions suitable for processing and application as a lining have of necessity to sacrifice to a certain extent the good abrasion resistance that can otherwise be obtained, so that in practice soft natural rubber is better in this respect.

Where accidental contamination with oil is inevitable, as in the case of some effluents and equipment having lubricated gears or bearings, neoprene will give the better service and, in practice, its higher cost than natural rubber (approximately 3s. 8½d./lb. as against about 2s. 2d./lb. which is the current price of natural) usually confines its use to those applications where it is strictly necessary on technical grounds.

Butyl rubber

Although natural rubber is remarkably stable compared with cast iron or mild steel in contact with many corrosive liquids, it is nevertheless composed of unsaturated molecular chains and possesses a degree of chemical activity on this account. With the discovery of 'butyl rubber,' by Thomas and Sparks of the Standard Oil Co., New Jersey, we have an elastic material, capable of being cross-linked but in which the number of double bonds is considerably reduced. As determined by a modified Wij's

procedure the unsaturation of butyl rubber is only 3% or less of the value for natural rubber and, as a consequence, the change in properties resulting from the action of heat and oxygen and even ozone is greatly reduced. Butyl rubber may give at least a tenfold advantage in heat resistance and will withstand a concentration of ozone of 0.04% indefinitely.

In spite of these particular advantages, its generally improved chemical resistance, its lower swelling in organic solvents and the fact that even at today's prices it is about 3d./lb. cheaper than natural rubber, butyl has not had the sweeping success as a rubber-lining material that its properties would appear to merit. This is partly due to economics, as it is a dollar import, and partly due to technical reasons. Compositions based on natural rubber are still superior in ease of processing and fabrication, that is to say smooth sheeting free from defects, free from dimensional change during vulcanisation and above all capable of being joined to itself, can be produced more readily by most manufacturers, and adhesive systems, having just the right amount of tack to hold the unvulcanised sheeting in place and yet release it when it is required to adjust the fit of the sheeting to the surface being lined, without impairing the ultimate bond to the metal, have not been developed to the same degree of efficiency for butyl as for natural rubber. It is not to be suggested that such difficulties will not be overcome both by increasing skill on the part of the lining manufacturers and by new developments from the makers of the raw material.

Brominated butyl rubber

A most promising development is that of a modified butyl rubber prepared by brominating the raw polymer either in solution by means of bromine or in the solid state by N-bromosuccinimide or N-bromoacetamide. The product, containing $2\frac{1}{2}$ to 3% substituted bromine shows excellent laminar adhesion both to unmodified butyl rubber and to unsaturated rubbers such as natural rubber and neoprene. It may also be mixed with the unsaturated rubbers, whereas unmodified butyl is unsatisfactory in this respect, so that we now have two means of compromising between the desirable properties of both types of rubbers.

Although brominated butyl will bond excellently to many metals primed with a phenol-formaldehyde resin, adhesives at present available based on this system await further improvement towards the most suitable degree of tack for holding the unvulcanised sheeting in place during the lining operation. However, excellent results can be obtained by using an interply of brominated butyl composition between the lining proper made from unmodified butyl, and a thin ply of neoprene which forms the bonding agent (through a suitable adhesive system) to the metal.

The present high price of brominated butyl, 5s. 8d./lb., limits its use in rubber lining work.

Rubber and plastics

Side by side with the development of synthetic rubbers several 'plastic' materials have been evolved, and users of chemical plant will be familiar, for example, with polyvinyl chloride and its copolymers and polythene. For the purposes of the present article,

Rubber lining work in progress on marine condenser door.

consideration has been limited to 'rubber,' as defined by a material made by cross-linking a high polymer with the result that the viscous component of its deformation mechanism is suppressed and the elastic component enhanced, the practical aspect of this so far as rubber lining is concerned being the raising of the softening point and, to a less important extent, perhaps, a lowering of the freezing point. With the advent of new methods of cross-linking, the terms 'rubber' and 'plastic' become less associated with distinct groups of materials and more associated with the definition of a state of matter.

A case in point is the modification of polythene into the synthetic rubber-like material *Hypalon*. By treatment with chlorine and sulphur dioxide, chlorine atoms and sulphonyl chloride groups are introduced at intervals along the molecular chains. In this way a vulcanisable rubber-like substance is obtained, the cross-linking agent being either litharge or magnesium oxide.

'Hypalon' as a lining material

At present expensive (about 9s. 3d./lb.), *Hypalon* is nevertheless of great interest as a lining material. It can be satisfactorily joined to itself and bonded to metal and its heat resistance and chemical stability are generally in advance of all other rubber linings. The susceptibility of rubber linings to the action of common oxidising agents such as chromic acid, nitric acid and hydrogen peroxide is well known, but *Hypalon* linings are suitable for chromium-plating liquors, resistant to dilute nitric acid (up to 70% at room temperatures and 20% at 70°C.) and strong hydrogen peroxide. They are virtually unaffected by ozone and will withstand 95% sulphuric acid at room temperatures.

Resistance to dry heat is also excellent, and good service may be expected at temperatures about 10 to 20°C. higher than with other rubbers.

In addition to such good chemical and thermal stability, *Hypalon* has good resistance to oils and some solvents. It is scarcely affected by mineral and vegetable oils at room temperatures, but would appear not to be satisfactory for use with chlorinated solvents or esters although suitable for the refrigerator coolant *Freon* 12.

It appears, therefore, that in *Hypalon* there is the best combination of properties available to date in a rubber-lining composition, and it is to be hoped that with the discovery of new cross-linking mechanisms other chemically stable but thermoplastic materials will be endowed with elastic properties over a wide range of temperatures.

Future outlook

Apart from the development of new cross-linking agents for existing polymers, including the application of atomic radiations, useful materials will probably result from the intense activity in the creation of entirely new polymers and copolymers.

As mentioned earlier, there is scope for the improvement of adhesive systems and there is need for continued effort in the elucidation of the mechanisms of adhesion.

Some further improvement in chemical and thermal stability is to be expected from studies of the free radical mechanisms involved in the oxidative degradation of polymers. The introduction of N: N'-dioctyl-

(*Concluded on page* 210)

British Chemical and Engineering Research

SUMMARY OF RECENT D.S.I.R. INVESTIGATIONS

Extraction of tar acids from tar oils

SELECTIVE solvent extraction of the phenolic compounds in tar oils is a potentially attractive alternative to the present caustic soda extraction process which involves extraction, purification of the extract, springing of the phenate solution with carbon dioxide, recovery of the caustic soda and final purification and drying of the crude phenols.

Organic bases have been investigated as selective solvents, but, although certain of these substances, *e.g.* monoethanolamine either undiluted or diluted with an equal volume of water, have the required solvent power and selectivity, they are equally good solvents for extracting bases so that the recovered tar acids are contaminated with pyridine and its homologues. More promising results have been obtained with a novel process which employs a solution of pyridine bases in sulphuric acid as the extractant, and separates the phenol from the extract by washing with di*iso*propyl ether. This method offers the possibility of simultaneous extraction and separation of both tar acids and tar base.

The foregoing is reported in the latest summary of the work of the Department of Scientific Research published recently. Other work of interest to chemists, chemical engineers, metallurgists and others is included in the following summary.

Corrosion inhibitors

The Corrosion of Metals Group of the Chemical Research Laboratory report a finding of great theoretical interest in demonstrating the close analogy between dry oxidation and protective film formation in an oxidising solution: in a study of the action of corrosion inhibitors using radioactive tracers, it has been shown that the growth of protective oxide film on freshly abraded steel in potassium chromate solution follows the same type of logarithmic growth-law as the actual and theoretically predicted growth of very thin oxide film in air.

Investigations on the influence of salts on the corrosion of mild steel in boiling solutions are providing information concerning the type and extent of attack to be expected from natural waters, including sea water, in boilers and heat exchangers. Chlorides of calcium, magnesium and sodium have shown marked differences in their effects.

Following the discovery that tannins in the soil at an archaeological site at Hungate were acting as inhibitors for sulphate-reducing bacteria, a recent excavation by the Ministry of Works at Chew Stoke has revealed an even more efficient natural inhibitor. Ancient metal objects, in a waterlogged soil normally regarded as aggressive, were in an excellent state of preservation. The inhibitor is believed to be a metabolic product of a species of actinomycetes, as previously found in a non-aggressive soil at Llandarcy. This mould grows freely on tannins, and also flourishes in peaty soils which are frequently non-aggressive. The identification of this product should be of both academic and economic importance.

Chemically modified cellulose

An investigation into the properties and possible uses of chemically modified cellulose as an ion-exchange material has been started by the Radiochemical Group of the Chemical Research Laboratory. Samples of both phosphorylated and aminated cellulose have been examined and other modifications are being prepared. It is possible to prepare paper sheets from the modified cellulose, on which a variety of separations can be carried out by the normal paper chromatographic technique but using simple aqueous salt solutions instead of organic solvents to develop the chromatograms. Alternatively, the modified cellulose can be prepared in pulp form suitable for packing chromatographic columns. The capacity of the modified cellulose is comparable with that of normal ion-exchange resins and the material is sufficiently stable to be used several times as a column packing material.

Rare earths and pure metals

Separation of the rare earths from each other has been further studied by the Inorganic Group of the Chemical Research Laboratory, using mainly ion-exchange procedures coupled with elution by means of complex-forming compounds of the amino-acetic acid type. Satisfactory separations, with relatively high concentrations of rare earths in the eluate, have been obtained, while considerable insight has been gained into the mechanism of the separations. In some cases the distribution of rare earth between resin and solution of the complexing agent has been followed by means of radioactive tracers. A semi-scale plant has been constructed to study these, and other separations, on much larger quantities.

The pure metals section of the group has begun an investigation for the Ministry of Supply on the purification to a very high degree of certain elements of interest in research on semi-conductors. The elements being studied are antimony, bismuth, gallium, indium, selenium and tellurium. Physical methods such as zone-refining, as well as chemical processes, are being examined.

Work on the search for, and the extraction of, selenium in flash-roaster wastes has been continued. Further likely sources of germanium have also been examined, while the possibility of recovering it from ammoniacal liquor is receiving attention. Although the amount present is very small, of the order of 5 to 10 p.p.m., the total quantity in all the liquor produced would be several tons.

The increasing use of pyrites for the manufacture of sulphuric acid is resulting in the production of large quantities of pyrites cinders. These cannot be used as a source of iron until the copper content has been reduced to acceptable limits. In a suggested process for achieving this a sublimate is formed containing zinc, lead and possibly cobalt besides the copper.

Methods for the separation and recovery of these metals from the sublimate are being examined.

The Organic Group has continued to devote considerable effort to the study of purification techniques, to the quantitative assessment of purity and to refined measurements of the physico-chemical properties of very pure substances.

Large-scale fractionation of polymers

New techniques are being developed by the High Polymers Group for the rapid and reliable determination of molecular weight distributions, and for the large-scale fractionation of polymers. Encouraging progress has been made with the latter problem by using membranes of graded permeability to effect the fractionation. A particular merit of this technique is that it should lend itself to eventual large-scale, semi-automatic operation.

The investigation of the preparation and properties of membranes which exhibit selective behaviour towards molecules or ions has continued as a subject of major interest. Two types of molecule selective membrane, one based on polyvinyl alcohol and the other on methoxymethyl nylon, have now been developed. The selectivity of these membranes may be varied over a wide range by suitable variation of the method of preparation.

Applications of ion-exchange resins

A new trend in the work on ion-exchange resins, carried out by the Food Investigation Organisation, is their use in thin sheets, adsorbed on an inert base where necessary. A coating of sulphonated polystyrene on diatomaceous earth has proved valuable in the chromatographic purification of insulin and a similar method for purifying meat myoglobin has been developed. Ion-exchange membrane cells have also been constructed, containing many narrow compartments separated by thin ion-exchange membranes, which permit the membranes to be simultaneously recharged by electrical instead of chemical means. The prototype bench-scale cell is being tested with plant extracts, and a larger semi-technical unit is to be built in collaboration with the National Research Development Corporation for test runs on materials of industrial interest.

Oils and chemicals from coal

In the Fischer-Tropsch synthesis, coal is broken down by gasification to simple units, carbon monoxide and hydrogen, which are then built up into whatever molecules are desired. In principle, therefore, this method should be adaptable to produce many different types of product, such as petrols, diesel oils, waxes and alcohols, but in practice there are difficulties, one of the most important of which arises from the large amount of heat given out in the synthesis reaction. Investigations have therefore been undertaken by the Fuel Research Station to establish the best means of controlling the reaction on an industrial scale, and a pilot plant treating 2,000 cu.ft./hr. of gas has been built to obtain a reliable assessment of various reaction systems and reactor designs for full-scale application.

The fluidised catalyst process having been examined, attention has been turned to an alternative method which would appear to offer certain advantages. This is the 'liquid phase' or slurry process in which synthesis gas is bubbled through a suspension of powdered catalyst in heavy oil or molten wax. Heat transfer in this system is good, so that a uniform temperature can be achieved by removing the heat of reaction by cooling tubes immersed in the suspension. The proportion of synthesis gas converted to methane is less than with other methods, and heavy oils and waxes can be obtained as major products; this is impracticable with the fluidised catalyst process where such products would cause the particles of catalyst to stick together and fall out of suspension. Preliminary details have been worked out from small-scale experiments, and preparations for trials with the pilot plant are well advanced.

In work on the recovery of germanium from coal products, it has been found that, on carbonisation of coals containing 6 to 10 p.p.m. of germanium, up to 90% of the germanium remains in the coke, which therefore becomes a somewhat richer source of germanium than the original coal. The dusts and deposits in the different sections of the flues of the coke-burning producer of a coal-carbonisation plant were then examined and it was found that the germanium contents of the dusts collected in the heating flues were small, but rose to a maximum of about 3% in the recuperator. Large proportions of the germanium are lost in the very fine dust passing out of the chimney, and samples of such dusts have been collected and found to contain 1% of germanium.

Chemicals from gasworks effluent

During a survey of the end uses of sulphuric acid carried out four years ago by the Intelligence and Information Division it was found that very large quantities of ferrous sulphate in an excess of sulphuric acid accumulated as a waste product and were discharged to sea. It was suggested that effluents might be treated with ammoniacal liquors from gasworks to produce ammonium sulphate (for sale as a fertiliser) and a hydrated iron oxide. The Gas Council has recently announced that, following successful pilot-plant runs, the industry is erecting a full-scale plant to prepare iron oxide and ammonium sulphate using 10,000 tons of ferrous sulphate a year. The iron oxide will be mixed with peat and used for sulphur recovery, thus providing an alternative to imports of bog iron ore which is used for gas purification. The new process will also mean a reduced demand for sulphuric acid by the gas industry.

Titanium alloys in engineering

Work on titanium, carried out by the National Physical Laboratory, has chiefly been concerned with the study of the metallurgical constitution of those of its alloys that are likely to find application in engineering, and of the effects of those impurities that limit the usefulness of the material. Detailed studies of titanium-oxygen and titanium-iron-oxygen alloys have been completed, and the influence of oxygen on titanium-aluminium alloys is being examined. New methods have been developed for measuring the heats of formation of titanium alloys, which are useful both in calculations concerning methods of extraction and in enabling some of the facts associated with the constitution of the alloys to be understood.

Carbonisation

The support and collaboration of a number of gas producer users and manufacturers has now been secured for further investigations of current problems of gas producer operation, the British Coal Utilisation Research Association reports. One of these is the influence of gas quality, particularly the tar content of the gas, on furnace performance. Apparatus incorporating a recuperator and a small furnace chamber has been constructed for studying the optimum temperature of preheat.

Work on problems of upgrading slurry has been continued. Agglomeration of coal fines has proved possible on an oscillating tray operating at carbonising temperatures; thereby it may be possible to produce a smokeless domestic fuel.

Hydraulic transport of solids

Fundamental work on the flow in pipes of liquid-solid mixtures has continued by the British Hydromechanics Research Association. The practical applications, particularly for

the transport of fairly large coal (up to, say, 4 in.) from underground are likely to be of great economic importance, and the Association has continued the work into the engineering development stage. The major practical problem is to evolve a machine which can raise the coal-water mixture to the necessary high pressure (say, 1,000 p.s.i.) without unduly damaging itself or the coal. The method put forward as the simplest one, pending the development of a successful coal pump, is to raise the water pressure by conventional means, and then to inject the coal into the high-pressure water by a specially designed feeder or loader. A machine developed by the National Coal Board from the original single-cylinder feeder built by the Association has been installed underground at a Scottish colliery and successfully tested. A new three-cylinder machine designed to load 50 to 100 tons/hr. has been built by the Association and is undergoing leakage and wear tests in the laboratory, prior to installation in a colliery for full-scale tests.

Sulphuric acid from waste pickle liquor

In previous summaries of work by the British Iron and Steel Research Association, mention has been made of the pilot plant for regenerating sulphuric acid from ferrous sulphate monohydrate extracted from waste pickle liquor. The optimum concentration of 40% acid was reached in trials on several occasions during 1955, and the plant has also operated satisfactorily both with indirect oil firing and with direct coal firing. The success of this pilot-scale work now makes it possible to design full-scale plants to regenerate dilute sulphuric acid economically from waste pickle liquor, thus solving a serious disposal problem.

Removal of impurities from copper

Three current researches are of importance in copper economics. During the smelting of copper some is lost in the reverberatory slags. The problem of preventing this loss is being attacked by a study of the solubility of copper in iron silicate slags. Analysis of these has presented great difficulty, but a suitable method has been developed. Secondly, the growing incidence in scrap copper of solder contamination has led to interest in the removal of the last traces of lead from molten copper in the fire-refining process. Suitable methods have been worked out and industrial trials have shown considerable savings in metal losses and reductions in processing time. Lastly, examination of the extraction of copper and elementary sulphur from copper ores by electrolysis in fused salt baths has led to a method for removal of sulphur and other elements from copper.

Tar research

Work on the use of coal gas as the source of hydrogen has been completed by the Coal Tar Research Association. Benzoles were found to be amenable to catalytic refining using coal gas at pressures of the order of 30 atm. and the gum content was reduced to a greater extent than when electrolytic hydrogen was used. On the other hand, the results with naphthas, in which good colour, colour stability and pleasant odour are more important than low sulphur content, were inferior with coal gas as the carrier; for the best results, however, the pressure used did not require to be increased above that yielding the optimum results using hydrogen. The use of coal gas as the hydrogenating medium has a serious disadvantage in that some of the hydrogen is used up, not in decomposing the sulphur compounds, but in reacting with the carbon monoxide; this leads to a considerable reduction in the thermal value of the coal gas used.

Chemical Engineering Patents

How far does the law help and protect the interests of chemical engineers? Patent laws and procedures are dealt with at length in a paper presented to the Institution of Chemical Engineers, in London, by Mr. H. I. Downes. Extracts from this paper appear below.

PATENTS are granted for new inventions, and the first meaning of invention as defined by the Patents Act, 1949, is 'any manner of new manufacture, the subject of Letters Patent and grant of privilege within Section 6 of the Statute of Monopolies.'

For chemical engineers that which is patentable can be classified and commented upon under four heads: (1) Chemical processes; (2) chemical products; (3) methods of testing and control; and (4) chemical equipment.

In (1) the process should be new to be patentable, but novelty here is intended also to cover an improvement in a known process. The process should also have involved at least a scintilla of invention.

Novel chemical substances (2) were first made eligible for patent protection in the present Patents Act. A patent claim for a novel chemical substance cannot include chemical products found in nature, but otherwise cover the chemical substance, however it may be prepared. Accordingly, the patent provides the discoverer with a most useful protection, although it does not necessarily nullify the value of any patent for a subsequently discovered, much-improved process for making the same chemical. Provisions in the law to remedy abuse of patents enable the holder of a patent for the improved process to seek a licence under the patent for the new chemical substance, on the ground that he is hindered or prevented by the earlier patent from practising his process. As a condition of obtaining this licence, he would have to grant the earlier patentee a cross-licence to use his improved manufacturing process.

All this involves a new field of patent activity which may have pitfalls only to become apparent later on. How, for example, is a new chemical substance to be sufficiently identified? Methods of testing and control, which must be applicable to the improvement or control of manufacture, and must be new, represent an extension of the definition of invention conferred by the present Patents Act. The field here is of immediate interest to the chemical engineer and often he is directly responsible for work of this this type.

Chemical equipment

The field of chemical equipment is perhaps the most fruitful for patents from chemical engineers. The diversity of such patents is considerable; they may include novel methods of constructing particular equipment and novel and ingenious plant layouts. There is a new provision regarding secrecy before patenting which bears particularly on this class of inventions. An inventor may try out his idea in public to see whether it really works, and can still secure a good patent by making application within 12 months of the trial.

Patent procedure

To secure a patent a formal application is made, accompanied by a patent specification which in the first instance may be either a provisional specification or a complete specification. The provisional specification will merely describe the nature of the invention, but the complete specification has to go further: it must describe the invention in detail and the way in which it is to be performed; it must disclose the best way of carrying out the invention known to the applicant; and it must end with a claim or claims defining the scope of the invention.

The drafting of the patent specification requires much care to secure that full justice is done to the invention, that the requirements imposed by the Patents Act and Patent Rules are observed and that accurate, lucid and unambiguous expression runs through the whole document.

A first need will be to define the scope of the invention. The true ambit of the invention will most probably be something more than a summary of the actual experiments or calculations performed, or the working models constructed. If the applicant conceives his invention too widely or too covetously, his patent claims may include much that is unworkable or without the merit or advantage which he asserts for his work. In this event his wide patent claims invite a judgment of invalidity. The applicant who relies on his own drafting skill will do well to take his task seriously. Not only should the method of performing his invention be explained by reference to all the variants which are applicable, but also full and accurate information is required on the best known method of practising the invention. Thus, where the invention is a novel chemical process, the range of operating conditions such as temperatures, pressures, reaction times, special precautions and so on should all be explained and details furnished of the known optimum operating conditions.

The novelty of the inventions are closely investigated and the patent specifications critically examined by Patent Office examiners. Their objections have to be fully met before the Patent Office accepts the patent application. After acceptance the documents are published and, within a period of three months from publication, interested parties may oppose the application on various grounds set out in the Patents Act. Assuming no opposition, on payment of a sealing fee an actual patent will then be granted to the applicant. It will ensure that, for a period of 16 years running from the date of filing of the complete specification, only the applicant is free to use the patented invention.

For the fifth and succeeding years of the life of the patent, annual renewal fees on an increasing scale become due in order to keep the patent in force and, failing payment of these fees, the patent will lapse; if this happens, anyone is free to make use of the invention.

Patent costs

Patent costs have shown some increase in post-war years. In some countries the increases have been quite substantial. In Britain the rise in patent fees has been comparatively modest. This increase occurred in the first half of 1955 and, as a result, the fees involved in filing a patent application and maintaining the granted patent for its full term rose from £130 to £173. Most of this increase is attributable to a substantial increase in the renewal fees payable over the concluding years in the life of a patent. Since patent fees in this country had remained unchanged for some decades there is cause for gratitude for a rather light escape.

The substantial increases in the cost of patent publications is a matter for concern. A patent specification at 3s. costs three times the pre-war price, and other Patent Office publications are much more costly. This sharp rise has to be considered against the background of the growth in patenting which has occurred, so that there is a much larger number of patent specifications which merit attention. It is not always practicable to consult a library holding patent specifications, and it would indeed be unfortunate if there were any narrowing of interest in patent specifications because of the increase of cost in procuring them.

Export of 'know-how'

There was a time when the chemical industry was in some degree dominated by German and Swiss interests. Industrial developments have since gone on apace in many parts of the world. Each development carries with it some opportunity for the export of 'know-how.' In that export is there a place for patents? At least one article in recent years has suggested that 'know-how,' growing in importance, is somehow supplanting patents and rendering them obsolete. The arguments for this proposition are backed by slender evidence.

Practice in the petroleum industry, for instance, gives little support for such a view. The industry, which is now increasingly participating in chemical synthesis, is international in outlook and in its trading interests. It is a commonplace of the industry, despite the considerable 'know-how' resulting from its operations, to consider patenting over a wide field. Only in this way can the many technical manufacturing and marketing interests be protected. Even with such patent activity there remains the necessity to seek and obtain patent licences from others for some of their activities.

There may be a few types of skill and knowledge which can command a good price unsupported by patents. If it is accepted that, with the growth of chemical activity in many other countries, the opportunities for the export of ideas or 'know-how' in the fields of chemical engineering are improved and enhanced, it is a matter for individual concern whether that export can be and is being facilitated by patents coverage in other lands.

There has rarely been any lack of appreciation of the virtue of seeking patents abroad on the part of technologists in other countries. Thus, of the patent applications filed in this country in 1952 and 1953, some 9% came from Germany and some 14% from the United States of America. Many of these patent applications from abroad are in fields of direct interest to chemical engineers. Those who, perhaps through tradition or some other factor, have tended to be content with patent coverage in this country, should also note two other factors tending to make any reliance on 'know-how' alone more hazardous. Freer and growing means of world travel leads more and more to the spread of technical knowledge. The increasing numbers of chemical engineers in many lands tend to secure the fuller utilisation of this spread of technical knowledge.

★ Personal Paragraphs ★

★ **Mr. D. R. Mackie** has been appointed managing director of Monsanto Chemicals Ltd. He has been acting managing director since November 1955 and was appointed a director of the company in 1952 and commercial director in 1953. He has just completed 32 years' service with the company.

★ **Mr. W. Lindsay Burns** has relinquished his post as managing director of Henry Balfour & Co. Ltd. after 27 years' service. His place has been taken by **Mr. Lindsay Burns, Jun.,** and **Mr. I. M. O. Hutchison,** who will be joint managing directors. Mr. W. Lindsay Burns remains as chairman and will act in a consulting capacity. He also stays as chairman and managing director of George Scott & Son (London) Ltd. and Ernest Scott & Co. Ltd., as well as chairman and managing director of Enamelled Metal Products Corporation (1933) Ltd.

★ At a meeting of the directors of the Power-Gas Corporation Ltd., of Stockton-on-Tees, **Major W. R. Brown,** D.S.O., was elected vice-chairman of the board. At the same meeting **Mr. T. K. Hargreaves,** D.S.O., was appointed a director of the company. Major Brown joined the company in 1928 for the purpose of taking over the development of their blast furnace business on the basis of collaboration with American blast furnace designers and specialists. He was appointed to the board of Ashmore, Benson, Pease & Co. Ltd. in 1942 and to the board of the Power-Gas Corporation Ltd. in 1944.

Mr. Hargreaves joined the company in 1936 and, as assistant works manager, played an important part in the planning of the new South Works which opened in 1951, by which time he had become works manager. He is also a director of Ashmore, Benson, Pease & Co. Ltd.

★ We regret to announce the death of **Mr. Vernon Young,** director of International Combustion (Holdings) Ltd., and chairman of its subsidiaries, International Combustion Ltd., International Combustion Products Ltd. and Riley (I.C.) Products Ltd.

★ Whessoe Ltd. announce the following appointments: **Mr. R. F. Bishop** as chief engineer (special developments) and **Mr. D. S. Hudspeth** as chief engineer (petroleum equipment).

★ **Mr. F. Gordon Kay,** sales manager of Acheson Colloids Ltd., left for an extensive tour of South America recently. His itinerary includes visits to Brazil, Uruguay, Argentina, Paraguay, Chile, Peru, Colombia and Venezuela. He will cover over 22,000 miles by air during his three months' tour.

★ At the annual general meeting of the Aluminium Development Association, the **Hon. Geoffrey Cunliffe** was elected president for the ensuing year, and the new vice-president is **Mr. Spence Sanders** (Almin Ltd.). **Mr. J. H. Mayes** (Northern Aluminium Co. Ltd.) was appointed chairman of the executive committee in succession to **Mr. Harold Goodwin,** who had completed two years in this office.

★ At the annual general meeting of the Society of Glass Technology held

Mr. F. Gordon Kay.

at Sheffield recently, **Dr. J. H. Partridge** was unanimously elected to the office of president, succeeding **Sir Graham Cunningham,** who retired after serving for two years.

★ At the annual general meeting of the Institute of Petroleum held recently, the following were elected: president, **the Rt. Hon. Lord Geddes;** vice-presidents, **Mr. E. LeQ. Herbert, Mr. R. B. Southall,** C.B.E.; member of council, **Mr. M. E. Hubbard.**

★ **Mr. A. Webb** has been appointed chief buyer of Albright & Wilson Ltd., following the death of Mr. C. H. Brennan in April. Mr. Webb's successor as manager, central traffic department, is **Mr. D. R. Thomas.**

Mr. W. Lindsay Burns.

★ It has been announced that **Mr. S. G. Deaves** and **Dr. W. D. Scott** have been appointed to the board of the British Tyre & Rubber Co. Mr. Deaves has been with the company since its formation in 1924, having been sales manager of the industrial products division, while Dr. Scott joined the company in 1954, with wide experience in important technical and executive positions in the chemical industry.

★ Sheepbridge Stokes Ltd. announce that **Mr. R. D. Millar** has taken up his appointment as sales representative in the north-western area which includes, North Staffs, North Wales, Lancashire, Cheshire and the Lake District as well as Northern Ireland.

★ Harold Andrews Sheepbridge Ltd. announce that **Mr. I. S. Horabin** has been appointed sales manager.

★ **Mr. Alan J. M. Millar,** of London, has joined the boards of Shaw-Petrie Ltd. and Clyde Tube Forgings Ltd.

★ **Mr. J. H. Pennington** has been appointed manager of Technical Ceramics Ltd., of Towcester, Northants, a newly formed company for the development and exploitation of ultrasonic materials and techniques. For the past two years he has been in charge of special products at the pilot plant of the chemical and metallurgical division of the Plessey Co. Ltd. at Towcester, Northants. Prior to joining Plessey, he spent some years with E. K. Cole Ltd. as technical representative.

British Patent Claims

The following are abstracts of some recent British patents which will be of interest to our readers. These abstracts are reproduced from the weekly Patents Abstracts Journal *by permission of the Technical Information Co. The complete specifications can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, price 3s. each.*

Steel production

Addition to Brit. Pat. 685,326. Slag, iron oxide and metal phases of a melt in a basic-lined refining zone are turbulently intermixed by injecting at the surface a gas of 21% minimum oxygen content (parent patent), with consequent simultaneous elimination of a maximum of 0.04% of phosphorus and a minimum of 4% of carbon, but leaving at least 1% of carbon in the metal. The intermixing is enhanced by the gases evolved during the elimination, and a minimum temperature of 2,500°F. is developed.—744,921, *Inland Steel Co.* (*U.S.*).

Liquid flow regulator

In a regulator for viscous liquids (*e.g.* furnace fuel oil), a valve is operated by a piston, etc., subjected to differential fluid pressure on opposite ends, which is produced by a choke tube, etc., in the fluid flow path. The valve is opened by the difference between the forces due to a weight and a spring acting on the weight, and is closed by the differential pressure.—744,813, *R. Thomas and Baldwins Ltd.*

Pipe coupling

A metal annulus is located between flared pipe ends and is externally threaded at both ends to be engaged by ring nuts between which and the annulus the flanges are gripped. The mating screw-threaded surfaces are so formed as to bind when the connection is fluid-tight (*e.g.* one is tapered).—744,886, *C. Nell* (*Switzerland*).

Heat-exchanger construction

In a heat exchanger (*e.g.* utilising furnace gases) in which a fluid(s) undergoes a change(s) of direction in the exchanger and in which secondary heat-exchange elements project into the fluid, such elements have guide members thereon which assist in the direction changing and are spaced apart along the line of flow of the fluid.—744,963, *J. Dennis, Soc. P.R.L. Bureau Technique* (*Belgium*).

Treatment of coal

Fine coal in the form of a dense, turbulent, fluidised mass is introduced rapidly to the action of a free-oxygen-containing, fluidising, gas stream at a temperature considerably above the normal carbonisation temperature, the conditions providing that the coal loses part of its volatile content without much carbonisation, so that the end product is mainly a coal of lower volatile content than it possessed originally.—744,745, *National Coal Board.*

Safety arrangement for pressure vessels

A door-securing mechanism incorporates a pneumatically operated door-locking pin, the position of which is controlled by a diaphragm-operated member whereby the pin is retained in its door-closing position when the internal pressure exceeds a predetermined minimum.—744,789, *Weston Electrical Instrument Corp.* (*U.S.*).

Liquid absorption of gases

The absorbing liquid is flooded through conduits on to the porous or foraminous bottom platform or diffuser of an absorption chamber. The gas or gas mixture is passed through the diffuser into the chamber so as to foam the flooded liquid upwardly, the foamed liquid being allowed to subside out of the top of the chamber into a collector to form a gas-enriched liquor.—744,785, *National Research Development Corp.*

Fluidised hydroforming process

The activity and selectivity of catalysts in fluidised solids hydroforming reactor systems is maintained at high levels even when running low-quality or high-sulphur feed stocks, by increasing the catalyst holding time in the regenerator to at least 35 min., and preferably to from about 1 to 5 hr.—744,687, *Esso Research & Engineering Co.* (*U.S.*).

Gasification of fuels

Production of synthesis gas by gasification of a suspension of finely divided carbonaceous fuel in a free-oxygen-containing gas. An annular stream of a chemically combined oxygen-containing fluid, capable of reacting endothermically with the fuel, is introduced into the chamber and unreacted fuel is allowed to contact and react with it. The hot reaction products are flowed through a fixed bed countercurrently to a moving, solid, tar-free, carbonaceous fuel, and useful gases removed from the other end of the bed; *cf.* Brit. Pat. 661,148.—744,702, *Koppers Co. Inc.* (*U.S.*).

Distillation apparatus

Distillation apparatus comprising a distillation column, a reflux condenser and at least one external film evaporator consisting of a heated upright evaporator tube in which a distilland can be evaporated in thin layers, wipers or brushes distributing the liquid over the inside wall and a pipe for introducing into the column the vapours generated in the evaporator.—744,844, *Farbenfabriken Bayer A.G.* (*Germany*).

Contacting device for chemical processes

Device for producing orientated circulating flows of gases and liquids and/or granular solids in reaction chambers or rectifying or contacting apparatus. The device has at least one horizontal area, *e.g.* plate, which is formed of separately constructed sections each carried by vertical supports, with several passages through the area (plate) and inclined relative to it.—744,906, *W. Kittel* (*Austria*).

Production of primary amines

In a first stage an aliphatic alcohol in the vapour phase is reacted with excess ammonia at 300 to 470°C. in the presence of an iron and/or iron oxides catalyst to yield a nitrile which, after separation of excess ammonia, is then reduced in liquid phase with hydrogen in the presence of a hydrogenation catalyst at 80 to 160°C. and a pressure >50 kg./sq.cm.; *cf.* Brit. Pat. 729,005.—744,851, *Ruhrchemie A.G.* (*Germany*).

Iron ore smelting process

In Brit. Pat. 744,596, a charge smelted in a low-shaft furnace using a blast of air (which may be oxygen enriched) contains a maximum of 5% by weight of pieces of size→25 mm., the ore and fuel being pre-mixed and top-fed either continuously or in small batches. In Brit. Pat. 744,654, a furnace has an annular charging space communicating by perforated walls with a central gas space closed at the top and open at the bottom. An outer annular gas space is closed at the bottom and open at the top to the gas outlet from the furnace. In Brit. Pat. 744,655, a rotatable central portion of the shaft wall is of downwardly tapering conical form, and is fitted with inwardly projecting agitating plates (*cf.* Brit. Pat. 744,658).—744,596, 744,654 *and* 744,655, *Ko-We Niederschactofen Ges.* (*Germany*).

World News

GREAT BRITAIN

British branch of Du Pont

The formation of a British subsidiary company, Du Pont Co. (United Kingdom) Ltd., has been announced by E. I. du Pont de Nemours & Co., U.S.

The initial project of the new company will be to provide herbicides of British manufacture. The products involved are the substituted ureas, known as *Telvar* herbicide for industrial use and *Karmex* herbicide for agriculture.

The new company also will explore the possibility of future manufacture and sale of other Du Pont chemical products in the United Kingdom.

Telvar and *Karmex* herbicides are among the Du Pont agricultural chemicals which are currently being imported from the United States and are being sold by Fisons Pest Control Ltd. as distributors in the United Kingdom, Eire and various areas in Africa. Fisons will continue in all these territories as distributors of British-made *Telvar* and *Karmex* for Du Pont Co. (United Kingdom) Ltd.

Change of name

Esso Petroleum Co. Ltd. has announced that the name of its research affiliate company in the U.K. has been changed from Esso Development Co. Ltd. to Esso Research Ltd. This step, it is stated, has been taken so that the name will reflect more accurately the company's varied and expanding activities in the field of petroleum research.

The company was originally incorporated as Esso Development Co. Ltd., in May 1946, though research had been carried on for some 12 years before that date under the name of Esso European Laboratories, first at Vauxhall and later at Abingdon in Berkshire.

With its new designation, the company will continue to co-operate with the Esso Research & Engineering Co. in the U.S. in carrying out research on behalf of the British, European and North African affiliates of the Esso group.

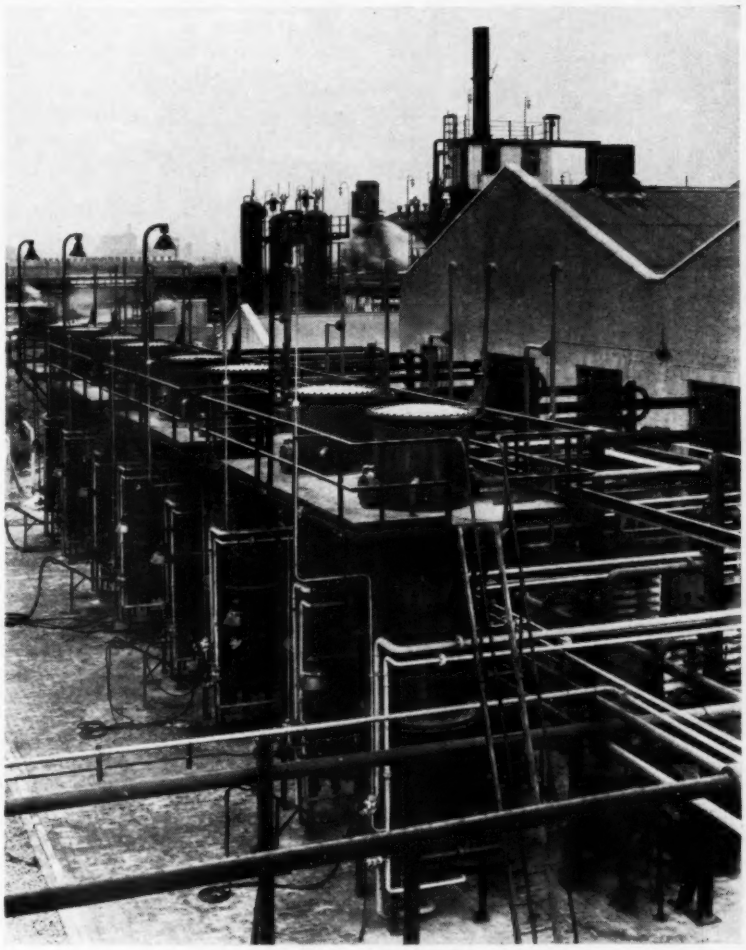
European atomic energy projects

The Nuclear Energy Committee of the Organisation for European Economic Co-operation has announced the establishment of a working party to study technical and financial problems of the joint establishment by O.E.E.C. countries of an isotope separation plant, a chemical separation plant for irradiated fuels, a heavy-water plant, prototype reactors and testing reactors.

I.Chem.E. annual dinner

The Institution of Chemical Engineers held its 34th annual corporate meeting in London recently, with the president, Mr. John A. Oriel, C.B.E., M.C., in the chair.

The following elections were made: *president*—Mr. John A. Oriel (re-elected); *vice-presidents*—Mr. G. U. Hopton, Prof. H. L. Roy (re-elected),



BRITISH GEON PLANT EXTENDED

Extensions to the Barry factory of British Geon Ltd. have recently been completed. The picture shows hydrogen chloride burners at the factory. Here, hydrogen chloride gas, one of the intermediate chemicals in the manufacture of Geon PVC, is synthesised. The number of these burners has now been doubled.

When this factory was first built in 1948 *the output of Geon PVC was* 6,000 *tons p.a. To meet growing demand for this versatile plastics material, the plant capacity has been steadily increased and first reached* 15,000 *tons p.a. by* 1955. *The latest extensions, completed in January* 1956, *have now raised production capacity to* 27,000 *tons p.a.*

The company report that today one of the largest and most important uses for Geon PVC is in the manufacture of fireproof coal conveyor belting used in the mines. Rigid PVC is being increasingly used for the manufacture of chemical plant. Demand for the many products made with Geon PVC paste resin continues to grow. Now this resin is to be used in quantity in the production of PVC foam.

Mr. P. K. Standring (re-elected) and Mr. A. S. White; *joint honorary secretaries*—Mr. F. E. Warner (re-elected) and Mr. R. C. Odams; *honorary treasurer*—Mr. F. A. Greene (re-elected); *members of council*—Mr. J. S. Brough, Dr. B. Edgington, Dr. J. F. C. Gartshore, Mr. L. W. J. Loveless and Prof. F. Morton. The continuing members of council are: Mr. H. D. Anderson, Dr. H. W. Ashton, Mr. W. E. Aylwin, Mr. C. G. Bacon, Mr. Keith Fraser, Dr. E. H. T. Hoblyn, M.B.E., and Mr. J. P. V. Woollam.

After the meeting, Mr. Oriel gave his presidential address on 'The Technological Awakening,' reported elsewhere in this issue.

In the evening, at the May Fair Hotel, the president and Mrs. John A. Oriel received 300 members and guests.

At the annual dinner which followed the reception, the toast of 'The Institution of Chemical Engineers' was proposed by Marshal of the Royal Air Force Lord Tedder, G.C.B., K.C.B., C.B., chancellor, the University of Cambridge. This was responded to by the president of the Institution, who proposed 'Our Guests.' Sir John Maud, K.C.B., C.B.E., Permanent Secretary, Ministry of Fuel and Power, responded on behalf of the guests.

At the close of the proceedings, the president presented the Osborne Reynolds medal to Mr. F. E. Warner for his services to the Institution especially as joint honorary secretary.

Polyvinyl acetate

British Oxygen Chemicals Ltd. announce that their polyvinyl acetate (PVA) will in future be known as *Vandike*.

Practical chemical engineering training

A scheme to give practical training to young men who are not entering a university after leaving school, but who are keen to take up chemical engineering as a career, has been introduced by Kestner Evaporator & Engineering Co. Ltd. The course will comprise ten sessions, taking five years to complete, appropriate periods being allotted to the laboratory, foundry, machine shop, pump shop, fitting shop, assembly shop, drawing office, outside erection, plant operation and office routine.

During the period of the training course the boy must attend an approved technical school or college to study for the Higher National Certificate in chemical engineering or some similar approved examination.

Dewrance form new division

The formation of a special alloys division is announced by Dewrance & Co. Ltd., makers of boiler mountings and piping valves.

This division will handle *Endewrance* high alloys which are claimed to be particularly suited for components in industry where heat-, abrasion-, corrosion- and erosion-resistant qualities are necessary. This division also handles the company's patent T.L.B. metal powder deposition process and powdered metals suitable for high-temperature brazing.

Dewrance are working in close collaboration with Coast Alloys Inc., Little Ferry, New Jersey, for the development and sale of high-alloy castings in Britain, the Commonwealth and a number of European countries.

Acheson plant for the Netherlands

Acheson Colloids Ltd., of London, manufacturers of *dag* dispersions, announce the incorporation of a new company in Rotterdam. Entitled Acheson Colloiden N.V., the unit will be responsible for the production of fine dispersions at a new factory now being constructed in the Netherlands. The factory, located at Scheemda in the province of Groningen, will be completed this autumn. The Plymouth works and London office of Acheson Colloids will provide key personnel.

Expansion of Society of Instrument Technology Ltd.

The Society of Instrument Technology Ltd. announces that, because of the continual growth of the Society and its activities and the increasing recognition of the need for automation in industry, a full-time staff with office accommodation has become desirable. Through the courtesy of the Council of the Scientific Instrument Manufacturers' Association of Great Britain Ltd., an office has been taken at 20 Queen Anne Street, W.1, and a full-time secretary and clerical staff engaged.

Changes of address

Pascall Engineering Co. Ltd. announce their removal to their new works at Gatwick Road, Crawley, Sussex.

The resins sales department of B.I.P. Chemicals Ltd. has moved from Tat Bank House to newly built offices nearer the resins plant; the move facilitates sales co-ordination with the factory. The address of the resins sales department is now Popes Lane, Oldbury, Birmingham (telephone, Broadwell 2061).

Distributors appointed

Brown & Forth Ltd., who are sole distributors in the U.K. and Eire for the organic chemicals department and the textile fibres department of E. I. du Pont de Nemours & Co., have been appointed distributors for the products manufactured by the electrochemicals department, which include *Darvyl* L-lysine monohydrochloride, polyvinyl alcohol and vinyl polymer.

Drying and air heating plant

Leonard Smith (Engineers) Ltd. have been appointed by Anhydro A/S, of Copenhagen, to handle their range of spray driers, flash drying plant and air heaters in U.K. This plant is complementary to the evaporating plant already designed by Leonard Smith.

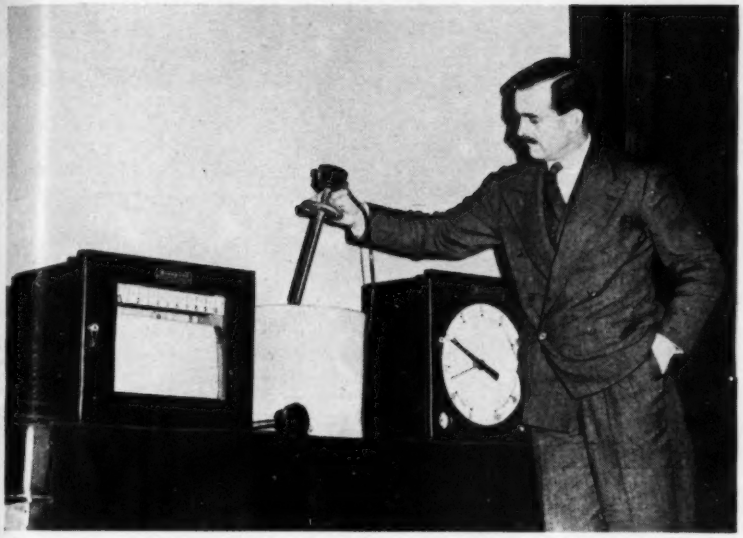
B.T.R. progress

Plans to re-site certain of the company's manufacturing activities at Leyland in a new factory in the same area were referred to in a statement by Sir Graham Hayman, chairman of the British Tyre & Rubber Co., circulated with the report and accounts. This, he said, would provide increased production of pipe and tank linings, roller coverings, cutless bearings and hose in new shops, and facilitate extended manufacture of other products at the existing Leyland factory. The rebuilding of the Silvertown factory is progressing satisfactorily, while at Fulham a new section for specialised hose production has recently been completed.

On the subject of product development, Sir Graham referred to *Pluvicor* fire-resistant conveyor belting, in which, he said, recent research and development enabled the company to incorporate 'anti-static' properties, this being a further contribution to safety in mines. The company has also acquired the rights of an entirely new and revolutionary fire-fighting hose, *Plastidry*, which needs no drying after use.

The plumber's business which grew up

With the celebration of its 21st anniversary last month, Shaw Petrie Ltd./Clyde Tube Forgings Ltd., a Scottish firm making and erecting pipe fittings, looks back to the time when a Mr. Shaw and a Mr. Petrie owned a small plumber's business at Braehead Street, Oatlands, with an enterprising young man called Hugh Miller. Two years after he had gained control of Shaw Petrie Ltd., this young man applied for modest factory space in the recently established Scottish industrial



Mr. A. J. Young, head of I.C.I.'s central instrument laboratory, lecturing on automatic process control to works, process, chemical and production engineers from major industrial organisations within a 50-mile radius of London. The lecture, held recently at the Royal Empire Society, London, was arranged by the Education Committee of the Incorporated Plant Engineers. The picture shows Mr. Young using a high-speed 'ElectroniK' recorder to demonstrate the high response speed of a properly designed thermocouple assembly.

estate at Hillington, near Glasgow. He had ideas on the making of pipe fittings that later proved to be quite revolutionary and remarkably efficient.

Eventually he established another company called Clyde Tube Forgings Ltd. to make, warehouse and supply standard lines of tube fittings for industry — petroleum installations, chemical plants, power stations, etc. —while Shaw Petrie Ltd. continued to make progress in the design, fabrication and erection of individual pipe-fittings for industrial projects.

Today this enterprising plumber's first staff of five at Hillington has grown to 1,200. The factory of 5,000 sq. ft. has spread to 150,000 sq. ft. There is an associate company in Canada and one in the U.S.; there are London, Belfast, Liverpool and Tyneside offices; agents and stockists represent the company in most countries of the world.

Clyde Tube Forgings claims to be the only company in Britain making pipe-fittings up to a diameter of 24 in. in a complete range.

CANADA

International Nickel Co. successes

The year 1955 was the most successful in the history of the International Nickel Co. of Canada Ltd., with net earnings and common dividend payments exceeding those of any previous year, Dr. John F. Thompson, chairman of the board, told shareholders at the company's annual meeting in Toronto.

He reported high deliveries of International Nickel's two principal products—nickel and copper—and increased output of most of the other elements obtained from its ores. At the same time he noted that considerable progress was again made in plant and process improvements and in development and research activities, and ore mined from underground and proven ore reserves were at a new high.

'The facts that free-world nickel production will probably increase and that purchasing for stockpile may be moderated suggest that there should be more nickel available for industry in 1956 and even more in 1957,' the chairman stated. Free-world nickel output for 1956 was estimated by Dr. Thompson at about 445 million lb., a gain of some 15 million lb. over 1955.

Titanium pigment plant

Canadian Titanium Pigments Ltd., a subsidiary of the National Lead Co., has begun construction of Canada's first titanium pigment plant at Varennes, Quebec, 15 miles north-east of Montreal.

The plant, which will be located on a 76-acre tract bounded by the St. Lawrence River on the north and a main highway and railroad on the south, will cost $15 million. The entire output of titanium pigment will go to Canadian industry. Construction will involve the installation of chemical processing equipment to extract titanium from its ore.

Production at the plant, which will employ about 300 people, is expected to begin next year.

Ferro-manganese plant

A $20-million manganese refining plant will be built near Woodstock, New Brunswick, for an annual production of 75,000 tons of ferro-manganese and 60,000 tons of ingot iron. Construction of the 1,800-ton refinery will start next autumn and it will be ready for operation in late 1957 or early 1958. It is understood the plant will help the Government's objective of having New Brunswick resources processed in the province.

New chemical plant

A $1,800,000 hydrogen sulphide extraction plant in the Peace River area, near Fort St. John, B.C., will be constructed by the Jefferson Lake Sulphur Co. in a joint enterprise with Pacific Petroleums Ltd.

The plant will initially produce 300 long tons of elemental sulphur daily, and within five years output will be increased to between 500 and 600 tons.

Pacific Petroleum are building an $18-million liquid hydrocarbon processing plant, from which hydrogen sulphide will be piped for upgrading.

AUSTRALIA

Carbon black project

Work has begun on a £2-million project for the manufacture of carbon black from special petroleum fractions at Geelong, Victoria, in Australia. It will be Australia's first petrochemical unit and the only carbon black plant operating in the southern hemisphere.

Designed to produce 16,000 tons p.a., this plant will be built and owned jointly by United Carbon Co., of Charleston, West Virginia, U.S., and Shell. When in operation it will provide the major types of furnace blacks required by the Australian rubber industry, plus a surplus available for export. The local manufacture of these blacks will save about £2 million of foreign exchange yearly and will make Australia independent of overseas supplies of an important range of strategic industrial chemicals.

The plant will be adjacent to Shell's refinery at Geelong, built at a cost of over £20 million.

FRANCE

Synthesis of granite

A French scientist has succeeded, for the first time, in achieving the synthesis of granite, according to a report from Paris.

The experiment was carried out on natural glass, obsidian, from the Lipari islands. A few grammes of glass were subjected to a temperature of 500°C. and a pressure of 3,000 atm. In a few days, fragments of rock were obtained which were entirely crystalline with the mineralogic constituents of granite.

New chemical plant planned

One of the biggest French chemical concerns, Rhone-Poulenc, has announced the formation of a new 750-million-francs company—Manufacture Normande de Polyethylene. This new company, in which Etablissements Kuhlmann and la Compagnie Francaise de Raffinages are participating, will use the Phillips Petroleum Co.'s production processes.

The new company's plant will be erected in the Le Havre area next to the oil refinery of Compagnie Francaise de Raffinages, which will provide the new plant with basic chemicals.

Erection of this new plant follows the recent announcement by the Société Ethylene Plastique of the setting up of a new branch to produce 10,000 tons p.a. of polyethylene.

Export aid changes

The French Government has modified the rates of export aid paid to certain industries with effect from July 1.

The main change concerns iron and steel products and coke and coal exported to countries outside the European Coal and Steel Community. At present, aid covers the reimbursement of social charges and 2½% of the value of these exports. As from July 1, however, only social charges will be reimbursed except for steel alloys, fine steels and rails, which will continue to enjoy the present rate of aid.

For potash products, superphosphates and some other minerals, as well as dextrines, social charges will continue to be reimbursed, but the remaining aid will be cut from the present rate of 5% to 2½%. Social charges will also be reimbursed for phosphate chalk, emery and asbestos, which are not receiving any subsidy at present. On the other hand, aid for electrodes made of artificial graphite for electric ovens will be discontinued.

Alcohol exports

The French Alcohol Office, a State body working under the Ministry of Finance, has received enquiries for the export of about 900,000 hectolitres of alcohol to the U.S. and about 360,000 hl. to the Soviet Union, according to usually reliable sources. Owing to lack of stocks held at present in France, however, it was believed that sale to the U.S. would be delayed until the next season and shipments to the U.S.S.R. would not take place until later this year.

The present shortage of alcohol in France is due to increasing domestic consumption and also to the fact that the Government had some time ago cut down beet allocations to alcohol refiners when stocks were high. About three years ago, surplus stocks of alcohol amounted to more than 1 million hl. As a result of poor beet crops and Government measures to reduce alcohol output, production declined to 2,690,700 hl. this year from 3,648,000 hl. in 1953-54 and 4,518,900 hl. in 1954-55. Consumption, on the other hand, increased mainly as a result of the development of French chemical production. Last year, chemical industries in France used 700,000 hl. of alcohol, as compared with 300,000 hl. in 1954. Total French consumption of alcohol is now estimated at 2,500,000 hl. plus 1 million hl. of 'ternary petrol,' an oil-petrol-alcohol mixture for motor-cars. It is believed that output of 'ternary' petrol will be reduced in order to make possible the export deals.

RUMANIA

New plastics material

Rumanian chemists of the chemical research Institute I.C.E.C.H.I.M. have this year introduced a new semi-transparent plastics material which they have named *Vinidur*, this being a derivative of polyvinyl chloride. At about 100 to 150°C. it becomes soft and can be moulded under pressure. At ordinary temperatures, the optimal range being between −2 to +60°C., it is hard and as tough as ebony, with a tensile strength of 400 to 600 kg./sq.cm.

Its special feature is its great resistance to chemical action; moreover, it is stated, *Vinidur* has no taste or smell and is therefore being successfully used instead of lead for water pipes. It is also being used for spindles in the textile industry and for apparatus of various kinds in the pharmaceutical industry.

UGANDA

Chemical industry development

The Uganda Development Corporation has announced that the Olin Mathieson Chemical Corporation of the U.S. will join with the U.D.C. and Frobisher Ltd., of Canada, in a new company to exploit large deposits of phosphates and niobium at Sukulu in eastern Uganda.

The new company, Sukulu Mines Ltd., will have a capital of £1½ million.

Because of the present limited markets for niobium (used in alloys for jet engines), the new company will concentrate initially on producing 100,000 tons p.a. of apatite (hard rock phosphates) by 1958. It could, however, produce up to 1 million lb. of niobium pentoxide p.a.

NORWAY

New aluminium plant to be ready in two years

A new aluminium plant to be built at Mosjoen, north Norway, with an output of 20,000 tons p.a., will be ready in 1958. The plant, estimated to cost £7½ million, will be two-thirds financed by the Norwegian engineering concern Elektrokemisk A/S and one-third by the Swiss company, Aluminium Industrie A/G. It is planned to extend the plant later to raise output to 60,000 tons p.a. Norway's total aluminium production last year was 75,000 tons, compared with 30,000 before the war. At the end of the war, in 1945, it was down to only 4,600 tons.

ITALY

Chlorine plant under construction

The largest chlorine producing plant in Latin America will be designed and built by Oronzio de Nora for Planta Colombiana de Soda on their existing site near Bogota. The plant will be designed to produce approximately 66 short tons of chlorine and 75 short tons of caustic soda per day. It is hoped, however, that even during the current year a daily output of some 40 tons of chlorine will be reached, together with the corresponding amounts of caustic soda and hydrogen. It is also anticipated that there will be a substantial production of ferric chloride, hydrochloric acid and bleaching solutions. The 80 tons of soda ash which Planta Colombiana de Soda already manufacture daily will be increased to 125 tons.

De Nora will install their mercury amalgam cells of the 14 TGL type and a mechanical rectifier. The large salt mines at Zipaquira and the two

salt recovery units at Galerazamba and Manaure, which belong to the Banco de la Republica, should prove a convenient source of raw material.

The consumption of chlorine in Columbia today is extremely low, but as soon as it becomes available in quantity at a reasonable price, there is no doubt that it will find a ready market and that it will encourage the development of new industries. The manufacture of detergents, fertilisers, insecticides and plastics are all expected to benefit from the availability of cheap chlorine, as are the paper and petroleum industries and the schemes for water purification.

RHODESIA

Concentrating plant opened

The concentrating plant at the Northern Rhodesian copper belt's newest mine at Chibuluma, which eventually will add another £5 million sterling to the Federation's annual income from copper, was opened recently. The plant, owned by the Rhodesian Selection Trust Group of companies, is the first new mine to go into production in the copper belt since before the second world war.

The new concentrator will crush ore, grind it and then separate any concentration of copper and cobalt minerals.

Estimated ore reserves at Chibuluma are 7,300,000 tons. About 480,000 tons will be hoisted yearly to produce 16,000 tons of copper worth about £5,600,000 sterling at present prices, and about £500,000 sterling of cobalt. The concentrator will treat 40,000 tons of ore a month.

HUNGARY

Chemical expansion plans

Proposals for the investment of £150 million in the next five years in the development of the chemical industry have been put forward. A major feature of these proposals is the completion of the fertiliser and plastics basic materials combine at Tiszapalkonya, which will process natural gas piped from Rumania.

By means of this plant, extensions to the new Borsod combine at Kazincbarcika and the established Pet nitrogen works, and the building of a new superphosphate plant at Szolnok, it is planned to multiply the 1955 output of nitrogenous fertiliser seven times by 1960, and to double phosphorus fertiliser output.

Plastics materials production per head of population (10 millions) is to be raised to 2½ lb., or more than four times the 1955 figure.

SPAIN

Pulp mill

The Istituto Nacional de Industria has applied for Government authorisation to build a pulp mill with an initial capacity of 30,000 tons p.a. of paper pulp, near Pontevedra, northwestern Spain. Of the planned annual production, 10,000 tons will be bleached pulp.

Raw material for the mill will be provided by pine wood growing in the area. It is planned to raise the capacity of the plant to 60,000 tons later and to build a paper mill in the vicinity.

AUSTRIA

Chemical scholarships

For the first time in Austria, scholarships sponsored by a private firm have been established. The first two, each worth £430, were awarded at the end of last year. They are intended to enable students to study chemistry, or some allied technical subject, for a period of six years at an Austrian university.

Instituted by Shell Austria A.G., two further scholarships will be awarded each year so that, from 1960 onwards, there will always be 12 Shell students at Austrian universities.

UNITED STATES

New aniline plant

The American Cyanamid Co. is starting construction of a plant to produce aniline by a catalytic process at the site of its Willow Island, West Virginia, plant. The new unit will have a rated annual capacity of 24 million lb. Completion of construction is scheduled for autumn 1957.

The decision to build at Willow Island was made, the company explained, because the rubber industry in Ohio and the surrounding area provides a substantial outlet for aniline. The new plant will use, for the first time, a fluid-bed reactor and new catalyst in the manufacture of aniline from nitrobenzene by the reduction process.

Dow project

The Dow Chemical Co. is starting a new Louisiana division which will build a $20-million plant to make caustic soda, chlorine and several organic chemicals in the Baton-Rouge-Plaquemine area.

The company has options on two locations of 1,700 acres and 1,100 acres on the west bank of the Mississippi.

Earth elements as catalysts

Great promise is shown by certain rare-earth elements as catalysts in dehydrogeneration reactions that produce high-octane gasoline, according to Doctor Vasili Komarewsky, Professor of Chemical Engineering at the Illinois Institute of Technology. He said studies also showed that rare earths might affect chemical reactions producing synthetic rubber and plastics. Research has shown that the oxides of two of the 15 rare earths—neodymium and samarium—were predominantly catalysts.

New nitrile rubber

Following an extensive laboratory and field testing programme, a new and improved light-coloured nitrile rubber is being released for sale by the rubber processing industry by the chemical division of the Goodyear Tyre & Rubber Co.

Designated as *Chemigum N6 B*, and employing a new and improved antioxidant system, this rubber is described as a non-staining, non-discolouring version of Goodyear's standard *Chemigum N6*.

New sulphuric acid plant in California

The Stauffer Chemical Co. is to build a sulphuric acid plant, costing approximately $2 million, at Dominquez, California. Full-scale production is scheduled for early in 1957.

Allied Chemical expansion plans

The Allied Chemical & Dye Corporation will spend about $80 million this year for improvement and expansion of facilities, or 40% more than in 1955.

While the company is not increasing its basic nitrogen production capacity, new facilities are being built for the output of ammonium nitrate in solid and solution forms to broaden the line of fertiliser materials.

Limestone plant modernisation

It was recently announced that the first step in a major modernisation programme with the addition of improved screening and sizing equipment would be undertaken soon at the Ingersoll limestone quarry of North American Cyanamid Ltd. More than 400,000 tons p.a. of limestone are produced at the quarry for processing at the Niagara plant, and for agricultural use. Cyanamid is engaging in an active programme to increase sales of limestone for metallurgical purposes and other uses.

RECENT PUBLICATIONS

Tower packing. A bulletin has been issued by Weinreb & Randall Ltd., the distillation specialists, to supplement their technical booklet on tower packings. This outlines new developments such as the British slot-wall ring in metal; the *Wirbelstrom* rings and *Super Berl* saddle in ceramic; also *Spraypak*, laboratory packings and high alumina balls for grinding, catalyst support and heat transfer.

Fluorocarbon rubber. The properties, applications, compounding, vulcanisation and fabrication of *Kel-F* elastomer — a fluorocarbon rubber which is claimed to have outstanding resistance to heat and corrosion—form the subject matter of new companion brochures published by the M. W. Kellogg Co., U.S.

Flexible metal hose. Details of potential applications of *Plessiflex* seamless, flexible, metal hose together with technical data including information on construction and assembly is contained in an illustrated brochure from Power Auxiliaries Ltd. This hose is claimed to be of particular value for the conveyance of liquids or gases at high pressures between junctions which may expand, vibrate, move angularly, or be exposed to high temperatures.

Cone crushers. An illustrated catalogue from Nordberg Manufacturing Co., U.S. describes the complete line of Symons cone crushers, built by Nordberg for the reduction crushing of ores, rock products and industrial minerals.

Titanium. Because of the increasing importance of titanium alloys, particularly in the aircraft industry, British Oxygen Gases Ltd. have been carrying out research in the welding of this metal. The findings of the research work have been embodied in a technical leaflet now available from the company.

Refrigerator lubrication is the subject of a well-produced, illustrated booklet from the Mobil Oil Co. Ltd., which opens with a discussion about the general principles of refrigeration, the means adopted to achieve it, and the fluids which are used as refrigerants. The booklet goes on to deal with general aspects of the construction and operation of refrigerating circuit units, the lubrication of compressors in refrigerating systems, and the compatibility of various refrigerants with lubricating oils which is treated at some length. The booklet also has a chapter giving a great deal of information of interest to plant operators. The final chapter sums up all lubrication requirements, and makes recommendations covering most of the different systems in use.

Process heating. From Barlow-Whitney Ltd. comes a 16-page catalogue describing a range of their smaller and profitable industrial heating equipment. Applications mentioned include the melting of glue and lead, dip tinning and soldering, impregnating with hot compounds or waxes, curing, drying, stoving, annealing, tempering and heating liquids of all kinds.

The Leonard Hill Technical Group—June

Articles appearing in some of our associate journals this month include:

Dairy Engineering—Cleansers for Aluminium Dairy Plant; The Preparation of Bulk Starter in a Cheese Factory; New Buttermaking Methods in the Soviet Union; Ice Cream Cup-Filling Machine Speeds Airline Catering Service in U.S.; The Early Days of Railway Milk Transport, 1.

Corrosion Technology—Corrosion Problems of Sulphuric Acid Plant; Corrosion of Packaged Articles; Spread of Protection.

Fibres—An Evaluation of the O.M. Super High Draft Spinning Unit: Wool Oils; Radioactive Isotopes and Their Use in the Textile Industry, 2; A Laboratory Test for Pilling.

Petroleum—The Production of Epoxides from Petroleum; Calibration of Oil Storage Tanks and Tank Vessels; The Significance of Laboratory Tests in an Oil Refinery; Hydrogen Attack on Refinery Equipment, 1; Recent Trends in Oil Geology.

Paint Manufacture—Applications of Statistical Methods to Technological Research in the Surface Coatings Industry; Anti-fouling Paints Progress, 2; Instruments for the Paint Industry; Location of the Paint Industry.

Atomics—The Use of Sodium and Sodium-Potassium Alloy as a Heat Transfer Medium, 2; Nuclear Power for Commercial Vessels, 2; Halogen-Quenched Geiger-Muller Counters, 1.

Manufacturing Chemist—Cosmetic Engineering, 1: Handling and Mixing; Manufacture of Lauryl Alcohols; Canadian Chemical Expansion; Radiochemical Laboratory of the U.S. Bureau of Standards; Progress Reports.

Food Manufacture—Meat Extract: A Revaluation; Processing Grapefruit in Florida; Food Facts and Fallacies, 1; The Pacific Fisheries' Experimental Station; Trace Elements in Foods, 2: Fluorine; Polyoxyethylene Monostearate in Bread Production.

Carbon fine-pore structure

It has been known for some time that the densities of synthetic carbons, as determined by liquid or gas displacement, are less than the densities obtained from *x*-ray diffraction measurements. This discrepancy has been interpreted as evidence of micropores which are inaccessible to the liquid or gas, either because they are too small to admit the gas or liquid molecules or because they are sealed off from the outside.

An investigation touching this problem has been conducted at the Battelle Institute. L. B. Loch and A. E. Austin of the Institute report that they studied the relationship between crystallite size and volume of micropores for a wide range of experimental carbons and graphites.

Using a sink-float method, they fractionated each carbon according to liquid-displacement density. *X*-ray diffraction measurements on a number of density fractions showed that the fine-pore content increased regularly with decreasing crystallite size. The results indicated that the fine pores are voids between adjoining crystallites. Thus the amount of fine-pore volume is proportional to the total surface area of the crystallites. The void thickness, *i.e.* the distance between adjacent crystallites, has a characteristic value in each type of carbon or graphite.

Rubber Lining

(*Concluded from page* 198)

or di-sec-butyl-p-phenylenediamine or 6-ethoxy-2:2:4-trimethyl-1:2-dihydroquinoline into natural rubber and also into butadiene/styrene type synthetics has improved their ozone resistance to an extent approaching that of the ozone-resistant synthetics. Although this is of perhaps very limited interest so far as rubber lining is concerned, it illustrates the point that methods of combating one form of degradation have been evolved to a degree that would have been scarcely thought possible only a few years ago. It is reasonable to anticipate that further discoveries of comparable significance will be forthcoming to aid the chemical engineer in the provision of plant to handle an ever-increasing variety of processes.

Acknowledgment

The author acknowledges the permission of the directors of the Andre Rubber Co. Ltd. to publish this article.

WHAT'S NEWS about

★Plant
★Equipment
★Materials
★Processes

This illustrated report on recent developments is associated with a reader service that is operated free of charge by our Enquiry Bureau. Each item appearing in these pages has a reference number appended to it; to obtain more information, fill in the top postcard attached, giving the appropriate reference number(s), and post the card (no stamp required in the United Kingdom).

'Proportiometer' pump

A variable-output plunger pump, the output of which can be altered from maximum down to zero whilst the pump is running, is now on the market. The pump is driven by a vertical-spindle electric motor mounted on top of the gear case which contains a worm reduction gear and all other mechanical parts of the pump. The output of the pump is normally controlled by a handwheel on the gear case and an indicator is provided to show at what percentage of its maximum capacity the pump is working. The output can, however, be remotely controlled by instruments.

The pump is of robust construction to cater for use in oil refineries and chemical works where operating conditions are severe and long runs without shut-down necessary. Special attention has been paid in the design to the question of maintenance, particularly as regards stuffing boxes and valves.

Amongst a number of applications of this development the following are mentioned:

(1) Injection of a small quantity of liquid into a main which has a varying rate of flow. In this case the rate of flow in the main is measured by a flowmeter which in turn controls the output of the injection pump, this keeping the ratio of the two liquids constant.

(2) Blending of two liquids in a specified ratio and varying throughout. In this case the flow from the pump handling one liquid is measured by a flowmeter which in turn controls the output of the second pump.

(3) Maintaining a constant pressure in a system regardless of rate of flow. In this case the pressure in the system is used to control the output of the pump, it being so arranged that as the pressure rises the output of the pump falls and *vice versa*.

(4) Reflex pumps for pilot-plant distillation columns in which the output of the pumps is controlled by column temperature.

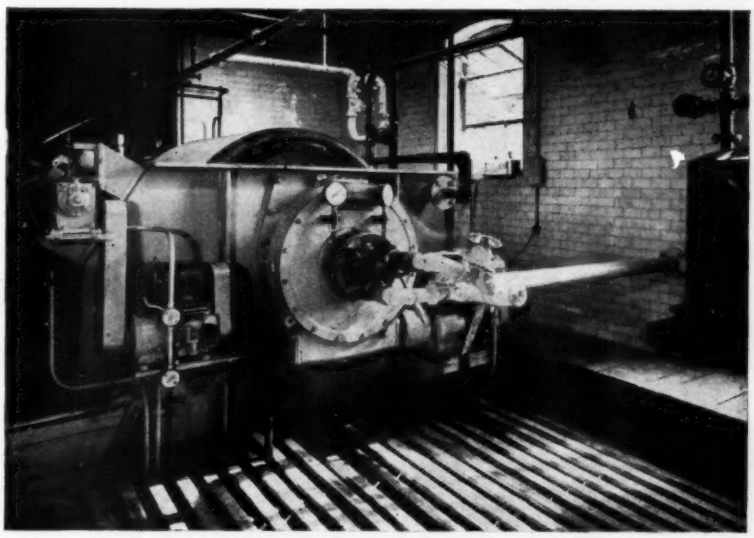
(5) Biological processes in which chemicals have to be injected at varying rates which may have to follow logarithmic curves or be based on certain time cycles.

CPE 248

Precoat filter triumphs in filtering yeast liquor

The problem of filtering the yeast extract liquor which is an intermediary in the manufacture of *Marmite* has always been most intractable, but new precoat filters which have recently been installed in the factory of Marmite Ltd. are reported to be very successful. Previously the liquor was treated in plate and frame filter presses which, although slow, was the only process that would deal with the yeast extract liquor.

The purpose of the filtering is to remove colloidal solids present in very low concentration in order to give a star-bright liquor. Several other



One of the two filters installed at the Marmite factory.

C.P.E.'S MONTHLY REPORT AND READER SERVICE

types of filter, including a centrifuge, were tried but failed to deal with the problem.

The new installation comprises two identical filters, each 4-ft. diameter × 4-ft. face, giving a total of 50 sq. ft. of filtering area per machine. The filters are constructed in mild steel which is *Lithcote*-covered in all places which can normally come in contact with the liquor. The internal piping of the drum is stainless steel. The filters are covered with staple nylon fabric, and *Colite* 512 is the precoat material. No filter aid is added to the feed slurry.

After initial teething troubles, this installation is working smoothly, efficiently and simply, and the plant has exceeded its design capacity by roughly 50%.

CPE 249

Demineralised water by ion exchange

A portable unit, charged with *Zeo-Karb* and *De-Acidite*, can be used for the production of up to 6 gal./hr. of demineralised water. This demineralised water is said to be of very high purity and suitable for almost all purposes where distilled quality water is needed. Running costs are low, and as the *Deminrolit* unit operates by ion exchange, no heat or power are used.

A pair of small closed cylinders contain the ion exchange resins, and a multi-valve control is used for directing the water through these cylinders in series. The first cylinder contains *Zeo-Karb* hydrogen ion exchange material which replaces metallic cations by hydrogen ions; the salts in the water are thus converted to the corresponding acids. This water then passes through the *De-Acidite* acid absorbing material contained in the second cylinder. The acids are absorbed, and treated water is produced which contains only traces of the salts originally present in the raw supply.

After the rated output of water has been demineralised, the ion exchange materials require regeneration. This takes about 1½ hr. to complete, after which the *Deminrolit* plant is ready to produce more demineralised water. The output of demineralised water produced per regeneration varies; when treating 'thin' waters a greater output per regeneration is obtained than with water more heavily charged with dissolved solids.

CPE 250

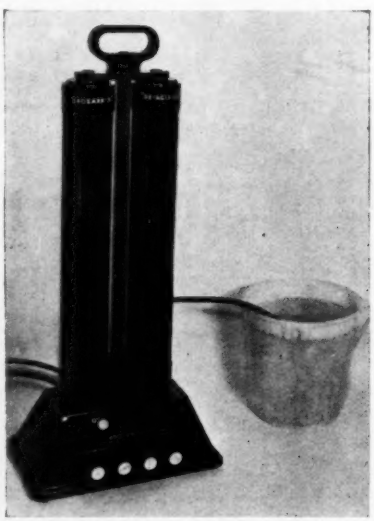
Industrial process refractometer

A new industrial process refractometer for continuous monitoring of process plant streams is now being manufactured by an American company. The instrument continuously measures the difference in refractive index between a flowing liquid sample and a reference liquid, thus monitoring changes in the sample. Measurement of refractive index is often the fastest and surest way of determining and controlling the purity of a flowing process stream. Variations in the stream can be detected in very short order and the necessary changes made to bring the product back to standard.

This analytical principle has wide applications in the petroleum and food processing industries as well as in chemical plants and in certain types of laboratory chromatographic analyses. Formerly, refractive index measurements were done in a laboratory on a small sample brought from the plant. Now, however, it is claimed that the measurement can be done continuously with an instrument mounted directly on the process stream itself.

Light is refracted when its velocity changes as it passes from one medium to another. This change in velocity causes the beam to bend or deflect from its original path. All transparent or translucent materials have a characteristic refractive index.

The refractometer features a sealed optical system, photocell detection, temperature compensation and a null balancing system for maximum accuracy. It is also explosion-proofed, the sample cell is readily accessible and results may be read directly from a dial or a remotely located recorder. The instrument is available in three models with ranges of limiting sensitivities covering 0.0001, 0.00001 and 0.000002. An accuracy better than ±½% is claimed. **CPE 251**



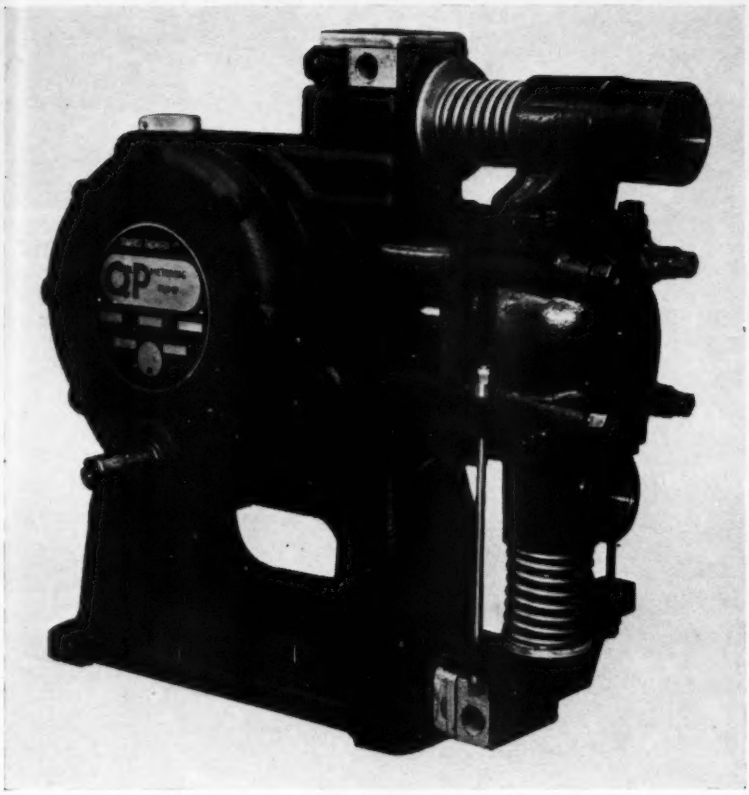
Portable 'Deminrolit' Mark 3 for demineralising water.

Recording and analysing data

A new system of data recording and analysis is intended for use in mobile vehicles such as aircraft, lorries, cars, tanks, etc., and also for use in confined space and in hazardous areas. It will record the outputs of all types of conventional mechanical and electrical transducers, and present them simultaneously as a permanent record on paper.

Magnetic tape is employed as the medium upon which the information is recorded, instead of the mirror galvanometer and photo-sensitive recording paper systems which have been current technique, particularly in the aircraft industry, for a number of years. The advantages claimed include very much wider frequency response, higher system accuracy and a record which is in a form entirely suitable for automatic analysis. The last-named feature, the makers point out, is of great importance because no wave form drawn on a piece of recording paper has any real value unless it can be interpreted, and the normal interpretation required is in terms of a frequency *versus* amplitude or power spectrum of a selected portion of the recording.

The system allows this to be done entirely automatically by a quite unskilled operator, whilst excluding reading and transcribing errors from the original record. The functions of recording and play-back are completely separated and the system of overall compensation and error correction allows for errors in the recording system where space is always a limitation, to be compensated on play-back. The provision of a calibrator unit by means of which the recorder may be set up for any predetermined sensitivity permits the recorder to be entirely dissociated from the play-back unit. The working capacity of the system as a whole may be doubled merely by adding a second recorder which is a comparatively cheap and simple unit. **CPE 252**



Metering pump.

Controlled liquid flow

Although new in its application to general fluid handling, the QP-Shirley metering pump has been in production for some considerable time for its original purpose—the feeding of a variable-controlled quantity of starch solutions to textile sizing machines. Production design has been entirely successful and, although external restyling has taken place, only detail modifications have had to be made to the original specification to make it suitable for general application.

This pump is claimed to be ideally suitable for any industrial, chemical or food production process where controlled transfer of any liquid—whether its viscosity is high or low—is required. Its inherently constant delivery per stroke—irrespective of wide variations in speed, viscosity, temperature or head—enables quantitative control of flow to be arranged either by absolute setting from a constant-speed source, to give controlled output in, say, gallons per minute, or by setting in relation to the velocity of some other part of the same plant which may itself be variable in speed.

CPE 253

Low-pressure pneumatic fly-ash handling

A comparatively new development in the technique of handling fly-ash is a low-pressure, pneumatic system which can be arranged to convey 20 to 100 tons/hr. up to distances of half a mile. It is arranged to handle fly-ash dry—a valuable feature if commercial use of the ash is contemplated.

The gravity conveyor system consists of an inclined trunking, which has a 'floor' section made up of a special fabric which is porous to air and resistant to high temperatures. The air pressure applied beneath this fabric cushions the dust resting upon it so that it will flow freely down an incline of as little as 5°.

Where long distances are involved, this system is used to collect the ash from several different boilers and convey it to a transfer point where it is collected from a buffer hopper by a Fuller-Kinyon pump and transferred to a storage silo by compressed air.

CPE 254

Climatic cabinet for humidity control

The *Weyco* climatic cabinet is claimed to represent a considerable advance in controlled humidity and to embody the following features:

Accurate temperature control; important since fluctuations in temperature cause fluctuations in humidity.

A positive air circulation which is controlled in such a way that it remains unaffected by shelf or cabinet loading and all parts of the working chamber are circulated with conditioned air. Each shelf receives its correct proportion of conditioned air, and this system ensures the same temperature and humidity throughout the cabinet. The conditioned air passes horizontally across each shelf; thus stratas of air or air pockets of varying degrees of temperature and humidity are avoided.

Air conditioning takes place in a treatment chamber. This treatment chamber surrounds the working chamber and it is in this chamber that the air is conditioned as required by the addition of moisture and/or heat. The conditioned air from the treatment chamber enters the working chamber on one side and is extracted from the chamber on the other side, and then passes through the treatment chamber again and is 'reconditioned.' There is, therefore, a continuous circulation of conditioned air passing through the working chamber, being reconditioned and recirculated round the working chamber.

Humidity which is created by the injection of atomised water into the treatment chamber where it is mixed with the temperature-controlled air and becomes conditioned. The amount of atomised water is automatically controlled so that the correct amount for the predetermined humidity is supplied. High humidities at low temperature are stated to be possible without affecting working temperature. This is a considerable advance on the present method of steam injection because the injection of steam inevitably raises the cabinet temperature and, when working at temperatures below 80°F. by this means, it is impossible to control the temperature of the cabinet. In addition, the injection of steam into a 'cool' cabinet causes condensation. With steam injection it is extremely

difficult to prevent ' creep ' and therefore accurate temperature and humidity control is virtually impossible.

The controls are extremely simple and consist of two dial contact thermometers (wet and dry bulb), a heater switch, a humidity switch and an air circulating fan switch. **CPE 255**

New vertical loading furnace

Steam as a protective atmosphere has been widely used for well over 60 years. It has, however, been partially superseded by other protective atmospheres because of the inconvenience of providing a separate steam generator. Moreover, the furnaces were not designed for the correct method of applying a steam atmosphere. However, with costs of production ever increasing, it has been necessary to look further into the use of steam as an atmosphere, with the result that a new vertical loading furnace incorporating a self-contained automatic steam atmosphere container for bright annealing of non-ferrous metals, blueing of steel tools and normalising of castings, etc., has been designed.

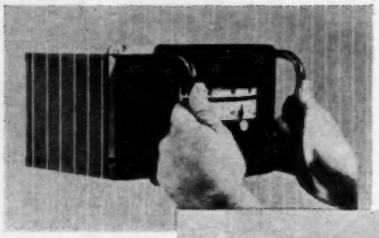
In this, steam automatically generated in a special container provides a cheap protective atmosphere for the heat treatment of non-ferrous metals, particularly for beryllium copper and the solution treatment of aluminium. No outside source of atmosphere supply is needed, and the range of manufacture being from ½ cwt. to 2 tons, will enable users with limited output to take advantage of bright annealing, etc., without the cost of installing a separate atmosphere plant.

As the charge in the container is quenched immediately after heat treatment, the container is at once available for the next charge, also, by means of quenching, a much smaller area of floor space is required for an equivalent tonnage treated.

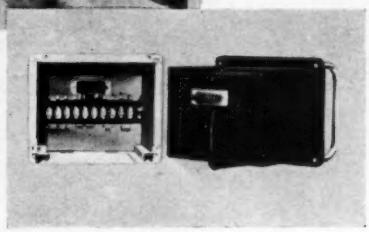
The larger plants incorporate fan circulation to ensure rapid initial heating.

Owing to the advantages of the design, the operation of the plant is extremely simple. One unskilled operator can manage three or four plants, dependent on the nature of the charge. Apart from the raising and lowering of the hoist and the loading and unloading of the charge, no other operations are required. The atmosphere is produced automatically.

CPE 256



Left: **Temperature control unit being slid into housing.**



Right: **View showing housing with instrument removed.**

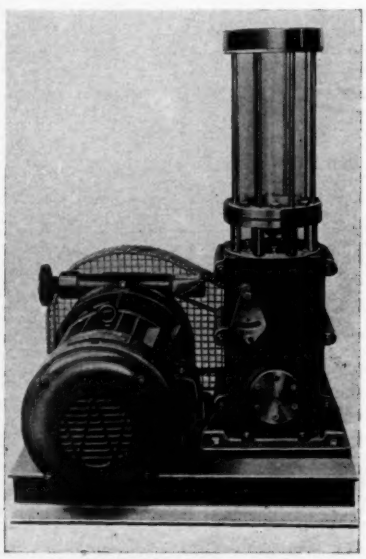
Plug-in instrument housing

A British firm announces a new accessory for its range of instruments whereby continuous operations involving temperature control are safeguarded from risk of shut-down.

This new plug-in instrument housing is designed for application on continuous processing where qualified maintenance staff are not generally available on all shifts and where, in the event of instrument lapse, the machine would normally be out of production. With this new accessory, unskilled labour can promptly replace the complete temperature controller and assure production continuity.

The new accessory consists of two units. One is the complete temperature control with hand grips and mounted self-aligning plug. The other section is the housing which receives the first unit and provides the matching socket and external wiring terminal block. Gold-plated contacts, wiping action and spring loading in the plug and socket assure trouble-free operation, it is claimed.

This assembly may be surface or flush mounted. To replace, it is only necessary to slide out one instrument and slide in the other. Thus, the makers state, an instrument can be replaced in less than 5 sec. without tools or recordable temperature variation. **CPE 257**



Sonic wave pulse generator.

Sonic mixer

A new wave pulse generator, suitable for the mixing, emulsification, impregnation, separation, etc., of foodstuffs, dairy products, wines and spirits and for many other applications, has been produced by a company specialising in mechanical vibrating equipment. The new generator is the direct result of over four years of research into wave and sonic energy transmission through liquids.

Known as the *Sonomec* energy generator, the new machine is primarily intended for use in laboratories where the highest standards are demanded, but it also has obvious uses in other sections of industrial and scientific research. It is a mechanical vibrator with great variability within the frequency range of 0 to 200 c/s. It consists essentially of a mechanically driven disc diaphragm which transmits vibrations to either liquids or solids

placed in the 1-gal.-capacity processing pot.

The linkage mechanism, driven by the 2-h.p. electric motor, incorporates a means of adjusting the amplitude of vibration in an infinitely variable manner. Frequency can also be varied without stopping the machine.

Large-capacity wave-pulse generators can be designed and supplied for carrying out processes on a commercial scale.

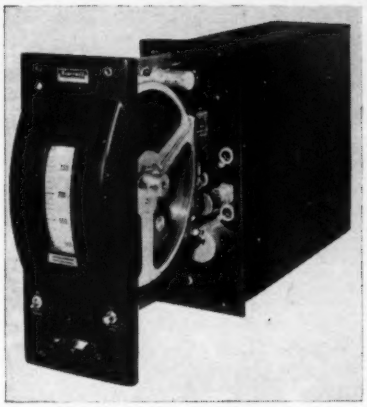
In this connection, the *Sonomec* provides a further advantage: it enables accurate experiments to be made beforehand so as to determine optimum frequency and amplitude of vibration. Thus a considerable saving can be effected in the capital cost of a large-scale machine because equipment for varying the vibration frequency and amplitude need not be incorporated and the generator need only be constructed to provide exactly those conditions required for the particular process. **CPE 258**

Moisture meter

A new instrument enables the moisture content of almost any material to be found immediately. The principle of the instrument, which is that of a dielectric constant measurement at a very high radio frequency, has been used in other instruments, but the makers state that the accuracy obtainable with this instrument is of an entirely new order, and measurements of moisture content to an accuracy of 0.1% moisture content are being made as routine procedure in many factories by unskilled labour. The meter is suitable for factory conditions, although its accuracy is of laboratory standard.

It is stated that, unlike other moisture meters, the readings obtained with this instrument are not greatly affected by the conductivity of the test material, or errors due to electrolytes in the sample. Temperature and packing errors have been largely obviated in this new instrument. To use the meter it is only necessary to place a weighed amount of any material into the instrument, which then indicates immediately the moisture content. The complete test takes only a few seconds.

Almost any problem of moisture determination can be solved by one of over 20 models currently available, and this is only one of a complete range of moisture meters which comprise recording, continuous indicating, and batch-type instruments which test samples with a volume of between 20 and 10,000 cc. **CPE 259**



SPACE-SAVING PRECISION INDICATOR

The face dimensions of an ElectroniK *vertical-scale precision indicator now available are* $6\frac{1}{2}$ *in.* $\times$ $15\frac{3}{8}$ *in. Five of these instruments can be mounted in the same panel space needed for two circular scale models. The new instrument incorporates the continuous balance circuit common to all* ElectroniK *instruments. Sensitivity is* $\frac{1}{32}\%$ *of scale span; accuracy is within* $\pm 0.20\%$ *of scale span.*

The highly legible rotating scale has a length of $28\frac{5}{8}$ *in.; 5 in. of it are visible through the window. A twin hairline index prevents parallax errors.*

The indicator chassis can be slid out from the front for inspection and service —without stopping operation of the instrument. **CPE 260**

New flameproof loudspeaker unit

Sound broadcasting is being used on an ever-increasing scale within industry to give wide coverage to staff announcements, personal calls, time signals, emergency calls and other messages. This coverage can now be increased still further following the introduction of a new loudspeaker horn driving unit for use in inflammable atmospheres. This is the first unit of its kind to receive the Ministry of Fuel and Power's certificate approving its use in atmospheres covered by Groups II and III of B.S. 229/1946 dealing with flameproof equipment. It can therefore be used to provide loud, intelligible speech in those sections of the oil, paint and chemical industries, for example, where direct sound broadcasting has hitherto been impossible because of the risk of fire or explosion.

The driving unit is a high-efficiency, pressure-operated device suitable for use with a projector horn or any well-designed re-entrant horn having a minimum air column length of 20 in. The speech coil and driver section, the magnet assembly and the line-matching transformer are all totally enclosed in a substantial aluminium alloy cast flameproof case.

Maximum reliability is ensured by the enamelled copper wire on the speech coil winding, with beryllium copper lead-out strips. The multi-ratio transformer provides various line impedances between 600 and 30,000 ohms; the power fed from the loudspeaker line to any unit may thus be individually adjusted to suit varying site conditions. The maximum power handling capacity is 10 watts and the frequency response 200 to 7,000 c/s. $\pm$ 3 db. **CPE 261**

Flameproof loudspeaker unit.

Two new industrial chemicals in U.S.

Two new chemical products developed by U.S. Government scientists are now available commercially for industrial use in the United States.

One of these products is maleopimaric acid, which is described as ' the first industrial chemical to be made directly from pine gum.' The acid is being used by the photographic industry and also has applications in paper coatings, printing inks and other products that required a plasticiser, emulsifier or resin.

The other new pine-gum is pinane hydro-peroxide (PHP), ' a catalyst for cold rubber production, with applications also in the production of certain plastics.' **CPE 262**

New dust-free building for precision instruments

It is essential that a dust-free and temperature-controlled atmosphere be provided for factories in which modern precision instruments and other delicate mechanisms are assembled and tested. The presence of dust can seriously affect the very minute adjustments which are necessary in electrical and gyroscopic equipment, and variations in temperature and humidity can cause almost imperceptible, but no less important, corrosion. Such faults might vitally reduce the efficiency of an instrument—such as an underwater cable booster—which must operate for long periods without maintenance. Dust-free buildings have been pioneered in America, but are still comparatively rare in the United Kingdom.

A plant recently installed in a British factory includes a recirculation-type ventilating scheme incorporating a filter capable of removing in excess of 97% by weight of airborne solid matter. This is combined with an insulated and dust-proof roof, a dust-free floor, dual heating systems and the elimination so far as possible of dust-catching fittings. Air is drawn in from outside or from the building itself and passed through a rotary-type viscous oil filter. It is then heated in a finned heat exchanger and redistributed to the building through *Air-master* diffusers fitted in the roof. Low-level extraction grilles return the air to the filter. Circulation is maintained by a fan of 5,000-cu.ft./min. capacity, driven by a 3-b.h.p. motor.

Supplementary heating is obtained from low-pressure hot-water radiator circuits. Both heating systems draw on a common gas-fired boiler and each is independently thermostatically controlled.

The roof is made up in part of double-pavement glass lights set in reinforced concrete and in part of wood-wool slabs faced with wood fibreboard lining. Lightweight mineralised felt is used as the outer roof covering.

The floor is of concrete, in which are cast the air-conditioning ducts and electrical wiring channels. Over this has been laid a coating of a dust-free plastic material, which is resistant to expansion stresses and provides a certain amount of resilience underfoot.

CPE 263

GAMMA-RAY CONTROL OF HOPPER LEVELS

A gamma-ray hopper level controller is available which consists of a suitable gamma source (*e.g.* cobalt 60 or caesium 137) and a detector so mounted that the gamma-ray beam passes through the vessel at the required control level.

The detector connects to a separate power pack and amplifier unit. This carries signal lamps and relays to indicate when the level rises above or drops below the radiation beam. Two or more units may be combined to obtain discreet indication and control action at a number of fixed levels. The makers state that the equipment is engineered for high reliability and easy maintenance under arduous industrial conditions, *e.g.* on ore hoppers in steel works, oil tanks, etc. It is also suited for detecting the boundary between liquids of significantly different density.

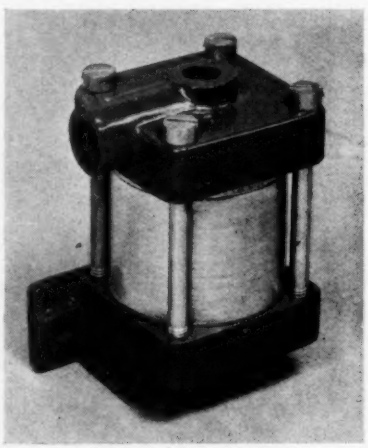
CPE 264

Electro-magnetic pilot valves

Electro-magnetic pilot valves of the 'glandless' poppet type are now available, employing a new type of actuator of advanced design and performance. Their makers claim that the development of a very efficient magnetic circuit, combined with optimum coil design, has resulted in a compact and powerful unit capable of handling fluids at higher pressures and flow rates than has previously been possible.

Two models are available at the present time, both utilising the same electro-magnetic actuator, but fitted with slightly different valve mechanisms. The unbalanced version has a full-bore capacity of $\frac{3}{32}$ in., and will handle compressed air or hydraulic oil at working pressures up to 150 p.s.i. The balanced version has a full-bore capacity of $\frac{3}{16}$ in., and will handle either of the above working fluids at pressures up to 100 p.s.i. Both units may also be used for vacuum service.

In both cases the electrical consumption is 4 w. maximum. There is no 'inrush' characteristic, as all models operate on d.c. A simple metal rectifier is supplied as a separate unit for use when working with an a.c. supply. With d.c. supplies at 130 v. or higher, a dropping resistor is supplied as a separate unit, the purpose of which is to avoid the use of very fine winding wires in the coil of the electro-magnet.



Electro-magnet unit.

The rating of the electro-magnet is extremely conservative, resulting in a maximum average temperature rise of the coil winding of 35°C. when energised for an indefinite period. It is claimed that the speed of response is very high and that the unit may be operated at frequencies in excess of 600 cycles/min. for any desired period.

CPE 265

Diaphragm-operated control valves

To meet the needs of process control systems where the pressure of the air supply is very low, an operating mechanism which is sensitive to air pressures down to 1 p.s.i. has been produced.

This high sensitivity, it is stated, is obtained by mechanically coupling a large, synthetic rubber diaphragm to the spool of the control valve. The pilot inlet connection is $\frac{1}{8}$ in. B.S.P. The system of unit construction on which the entire range of equipment is based makes it possible for the diaphragm operating mechanism to be fitted to $\frac{1}{4}$-in. and $\frac{1}{2}$-in. bore, two-, three- and four-way valves.

CPE 266